POWER PLANT ENGINEERING

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Vacuum Oil Co. Plant at Paulsboro, N. J.

POWER PLANT FOR REFINERY BUILT DURING WAR-TIME PERIOD HAS FINE OPERATING RECORD

SEVEN YEARS OF CONTINUOUS operation with absolutely no interruption in the steam supply and only a 3-hr. interruption of electrical service is a record that might well incite the envy of any conscientious industrial power plant operator. Yet, such a record is held by the power plant of the Vacuum Oil Co. at its Paulsboro, N. J., refinery. With the first section completed in May, 1917, this plant has been in continuous service ever since, although during this time the capacity has been increased considerably by the addition of new boilers and generating units. The last addition included an entirely new boiler house, separate from the original one. These new additions were constructed under the trying conditions of the war-time period, when great difficulty was had in securing materials, labor and fuel, and when unusual government demands imposed a serious strain upon the entire organization. In spite of these handicaps, service was maintained at all times.

This plant is an exceptionally fine example of an oil refinery power plant. It serves the entire refinery with steam, power and water for all purposes, and consists of a boiler house built in two sections, together with a turbine room, compressor room and a water softening plant. It is located at Paulsboro, N. J., about 15 mi. above Camden, on the Delaware River. This location provides excellent docking facilities and the company owns its own steamers by which practically all of the crude oil is delivered to the refinery.

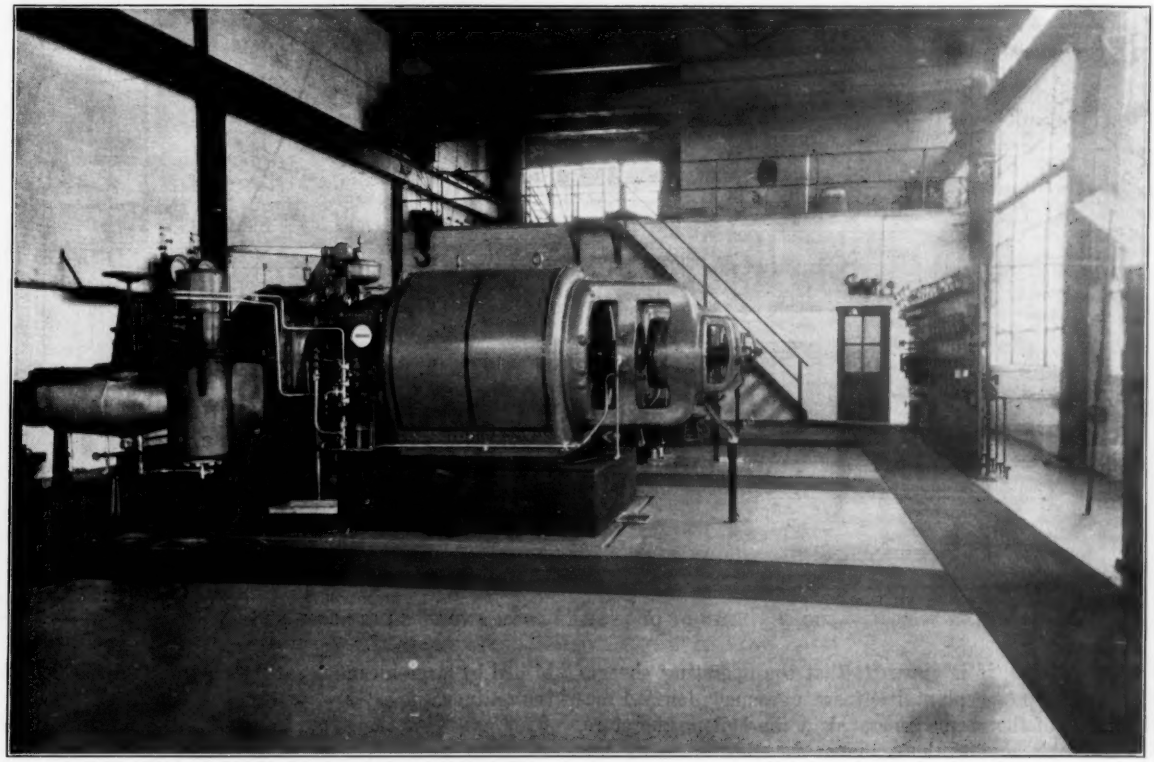


FIG. 1. NEATNESS IS THE OUTSTANDING FEATURE IN THIS TURBINE ROOM

All electric power used in the refining processes is generated at the plant by turbo-generators at a potential of

2300 v. All of the turbines operate non-condensing against a back pressure of about 20 lb. The exhaust steam at this pressure is then delivered to Foster superheaters connected in the oil still flues, after which it passes on for use throughout the refinery. The turbine units, therefore, merely abstract the available mechanical energy in the steam and in this capacity act as reducing valves for reducing high pressure steam to a pressure suitable for use in certain refining operations.

By charging the refinery for the exhaust steam on a heat unit basis, it is apparent that the operating charges against the power plant itself are extremely low. Practically all of the steam generated in the boilers, therefore, is chargeable against the refinery. In addition to the low pressure steam furnished by the turbine exhaust, a great amount of high pressure steam is also used in the refining operations.

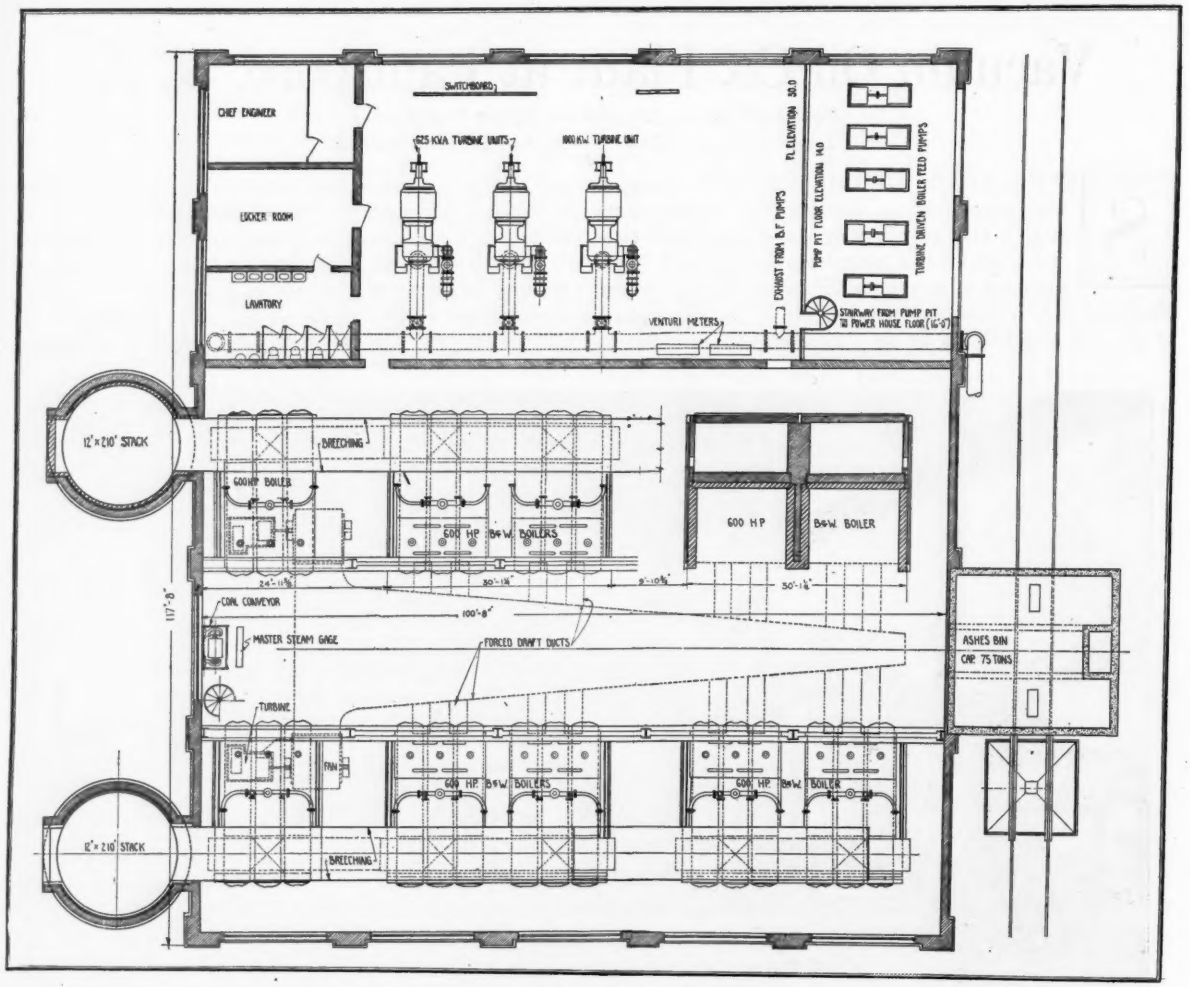


FIG. 2. PLAN OF OLD BOILER ROOM AND TURBINE ROOM

General Arrangement

A plan of the turbine and boiler room, not including the new boiler room, however, is shown in Fig. 2. The boilers, it will be noted, are arranged in two rows, one on each side of the firing aisle, with the stacks at one end. The new boiler house is in line with the old, to the left of the stacks. The relation of the old and new boiler house with respect to location is shown more clearly in Fig. 5. The turbine room is adjacent to the old boiler house with the pump room at one end and the chief engineer's office, the locker room and lavatory at the other. The air compressor room is located at the left of the turbine room but is not shown on the drawings.

The buildings are constructed of brick and steel, with concrete floors. Large windows on all sides of the building, together with skylights, provide ample natural illumination during the daytime, while at night illumination is furnished by large incandescent lighting units suspended from the ceilings.

Boiler Room

Steam is generated at about 185 lb. pressure in 14 water-tube boilers having a combined rating of 8400 hp. Ten of these are Babcock and Wilcox units of 600 hp. each, equipped with B. & W. superheaters, while the remaining four are Geary water-tube boilers, also of 600 hp. each but having Foster superheaters. Six of these B. & W. units were included in the initial installation. All boilers are fitted with Copes feed water regulators and Bailey boiler meters. Each B. & W. boiler is equipped with three blowoff connections, each consisting of an Everlasting Straight through and a Yarway blowoff valve in combination. The

Geary boilers are equipped with 2½-in. blowoff connections. All boilers have Nelson stop-valves and either Foster or Lagonda non-return valves.

When the plant was built, coal was still comparatively cheap, and for this reason eight of the boilers are equipped with Riley 5-retort underfeed stokers. Since that time, however, it has been found more economical to burn oil and gas and the stokers are not being used. They have been bricked over in order to permit the burning of oil and gas but in case it becomes necessary to revert to the Acid Sludge. When it was first decided upon to use oil at this plant, a relatively good grade of oil was burned. When the United States entered the war, however, government demands made it necessary to use a lower grade, and this occurred about three times, until finally the only fuel available for use in the power plant was the Panuco Crude and Acid Sludge. This condition, of course, introduced a great amount of trouble with burners, and with each change of fuel oil it was necessary to modify the burner design. At the present time a burner of the engineering

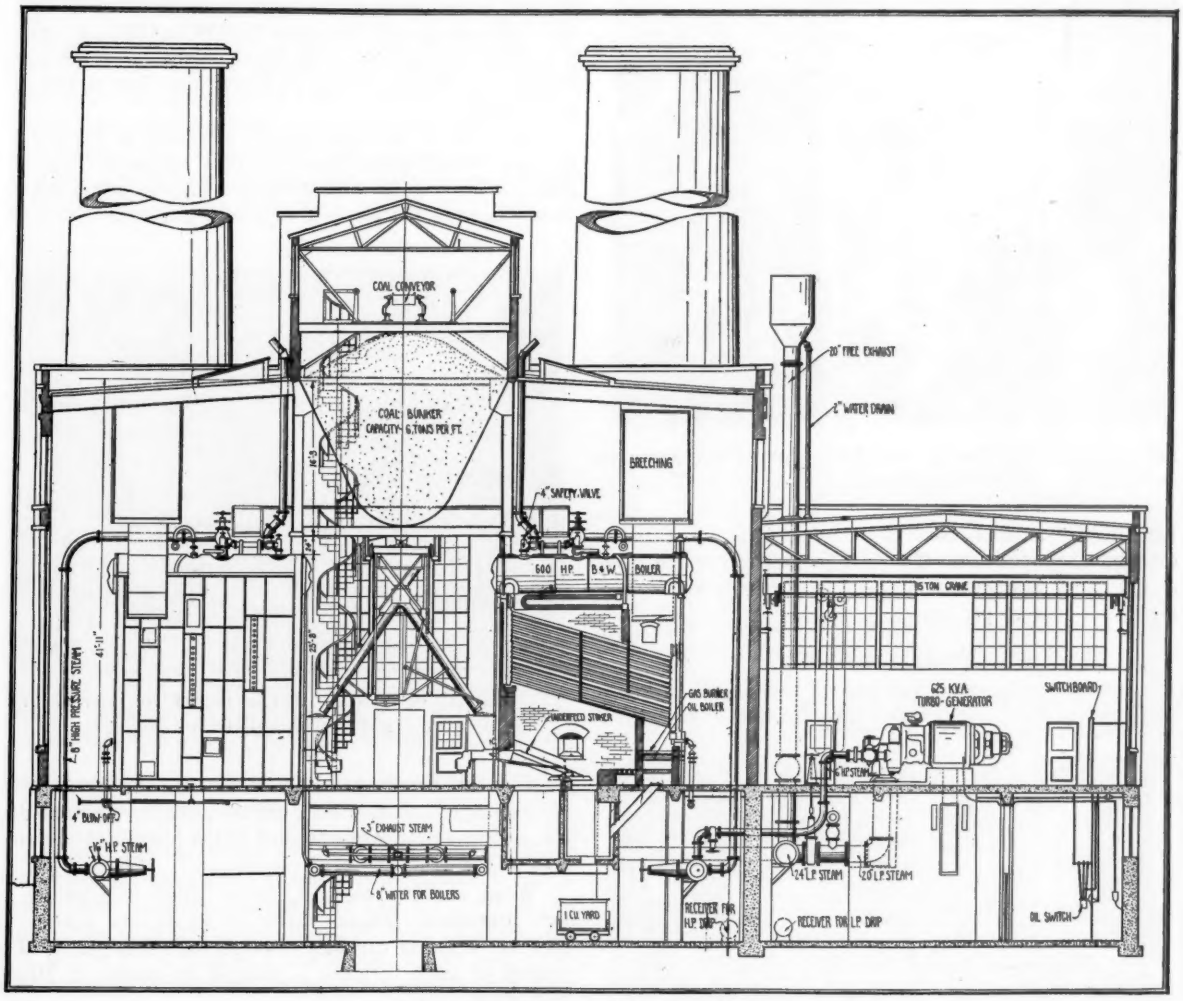


FIG. 3. SECTION THROUGH BOILER AND TURBINE ROOM

use of coal, this brickwork can be removed in a comparatively short time. The stokers, therefore, are being used merely as an emergency proposition. Six of these stokers are driven by Sturtevant vertical engines and two by slip ring induction motors.

At the present time all boilers, including those not equipped with stokers, are fitted with both oil and gas burners at the rear of the furnace. A view of these burners on two of the boilers is shown in Fig. 4. The oil burners are arranged slightly below and between the gas burners. The oil and gas lines, it will be seen, do not interfere in any way with the blowoff lines.

Oil used in firing these boilers is of an extremely poor quality and is known at the refinery as Panuco Crude and department's own design and manufacture, using steam for atomization, is used with good satisfaction. The wear on these burners is considerable but they are simple in construction and inexpensive to make.

The oil is preheated to a temperature of between 125 and 150 deg. F. in storage tanks by means of exhaust steam flowing in closed coils. From these tanks the oil pumps deliver the oil to heat exchangers, where it is heated to about 200 deg. under pressure and then delivered to the burners.

Three fuel oil pumps are provided. These are National Transit Co. units, 7 by 10 by 14 in., connected through a double system of headers, and controlled by Fisher governors. On the suction side, these pumps are connected to

three different sources of supply, i. e., from the main power house storage tanks, from the large storage tanks on the "Farm" and from the refinery tanks. An interruption due to lack of fuel is, therefore, a remote possibility.

The gas used under the boilers is "still gas," a by-product of the refinery operations and if not used for fuel would ordinarily be wasted. The oils, too, are of too low a grade to permit of being sold. It is apparent, therefore,

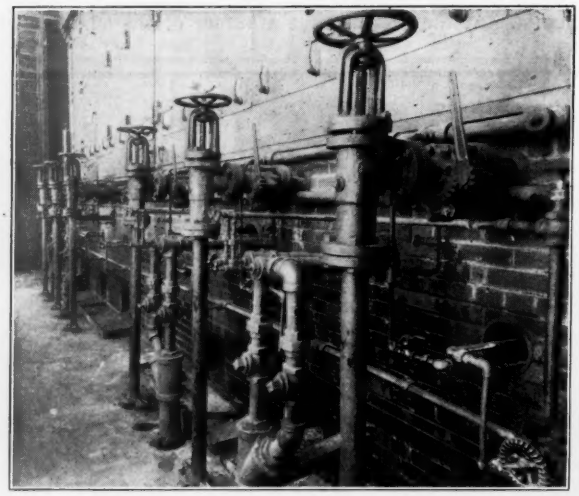


FIG. 4. VIEW AT REAR OF BOILERS, SHOWING OIL AND GAS BURNERS

that insofar as fuel used is concerned, the plant is an economical proposition. The CO_2 content of the flue gases at this plant averages from 12 to 14 per cent, with excess air of not over 20 per cent.

Furnace Design

In order to burn oil and gas, it was necessary to redesign the stoker fired furnaces installed under the boilers.

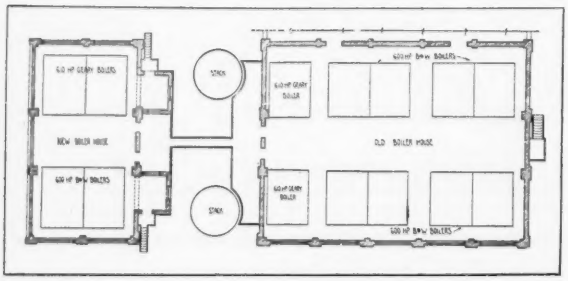


FIG. 5. DIAGRAM SHOWING RELATIVE LOCATION OF BOILER ROOMS

Details of these furnaces are shown in Fig. 8. Referring to the longitudinal section, it will be seen that the burners extend into the furnace for a distance of slightly over 5 ft. The oil burners enter through 6-in. pipe sleeves and the gas burners through 8-in. pipe sleeves. Air for combustion enters both through the burner pipe sleeves and through a checker work of fire brick placed directly below the burners, as shown. This checker work serves to heat the air as it enters the furnace. Each furnace has five burners, two gas burners and three oil burners. The stokers at the front of the furnace, as stated previously, are bricked over so that the heat of the furnace will not damage them.

In Fig. 10 is shown a photograph of the front of one of the boilers not fitted with stokers. The permanently installed peep holes will be of interest. These, as may be noted, consist of three circular holes in the furnace front wall, covered with a circular steel plate. Immediately in front of these holes at a distance of about a foot from the furnace front are suspended sheet iron plates fitted with a blue glass windows. If the fireman wishes to inspect the interior of the furnace, he merely has to slide back the circular plate covering the aperture in the furnace front and look through the blue glass window in the iron frames. A similar arrangement is employed on the stoker equipped furnaces, as shown in Fig. 9, which is a view of the old boiler room.

Referring to this photograph, attention is directed to the coal handling equipment. This equipment was installed to supply the stokers with coal, and while not in use at the present time, is always kept in readiness.

FIG. 6. THE CHEMICAL MIXING TANKS FOR THE WATER SOFTENING APPARATUS

This coal handling equipment consists of a 500-T. overhead storage bunker, a Peck carrier made by the Link-Belt Co., and an electrically operated weigh larry, also of Link-Belt manufacture.

When running on coal, forced draft is supplied by two Sturtevant blowers, both of which are driven by Sturtevant steam turbines through reduction gears. The control of these turbines is effected by means of Mason regulators.

The Peck carrier is also used for the removal of the ashes from the boiler room basement. When used for this purpose, it delivers into a 75-T. ash bin located on the outside of the building, as shown on the plan view. Two Custodis stacks are provided. These are 210 ft. high, 19 ft. in diameter at the bottom and 12 ft. at the top.

Raw water from the Delaware River is pumped to the oil stills, where it is used for cooling purposes. After passing over the still condensers, it flows to two storage tanks of approximately 450,000 gal. capacity each. From the storage tanks it is picked up by two circulating pumps, one a Norris 750-g. p. m. pump driven by a Kerr turbine and the other a Worthington unit driven by a G. E. Curtis turbine, and sent through waste heat economizers connected in the still flues.

Next, the water passes to the water softening building, where the temperature is raised to approximately 180 deg. by means of exhaust steam in open heaters. Soda ash and lime are introduced into the water at this point and it then enters the treating tanks. There are two treating tanks, one of which has a capacity of 100,000 gal. per hr. and another having a capacity of 50,000 gal. per hr. This method of treating the water has proved extremely effective and troubles due to the formation of scale in the boilers has practically disappeared since the treating apparatus was installed. The action of the treating system is well illustrated in Fig. 7, which shows a sample of the untreated water at the left, a sample of the treated water in the center, and at the right a sample of the sludge which was taken from the bottom of the treating tanks. Two samples of scale taken from the boilers before the treating apparatus was installed, are also shown in this photograph.

After having been treated, the water flows through filters and then to the boiler feed pumps for delivery to

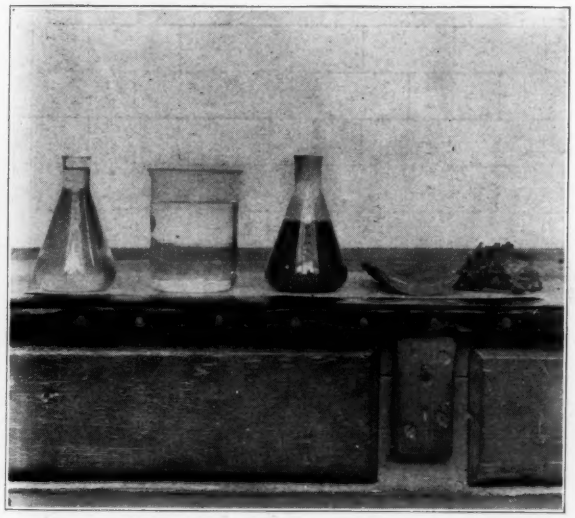


FIG. 7. PHOTOGRAPH OF WATER SAMPLES, SHOWING EFFECT OF WATER TREATMENT

the boilers. Three of the five feed pumps installed are Lea-Courtenay units rated at 450-g. p. m. against a 600-ft. head, driven by Kerr turbines, and two are 750-g. p. m. units of the same make, also driven by Kerr turbines. All feed pumps are controlled by hand. A double feed water header system is installed throughout to insure continuity of service.

It will be noted from the foregoing description of the feed water system that heat is picked up at several points before the water enters the boiler. First, it receives some heat in the oil stills, where it is used for cooling; second, it is heated in the waste heat economizers, and finally, it is heated in the feed water heaters. With the river water at a temperature of 40 deg., it is possible to pick up about 100 deg. before it enters the main feed water heaters.

While most of the water used is river water, there are also a number of deep well pumps which may be used if necessary. The amount of water used is considerable, as no condensate is returned to the boilers.

Turbines and Generators

Electricity is generated at 2300 v. three phase, 60 cycles by three General Electric Co. turbo-generators having direct connected exciters. Two of these machines are of 500 kw. capacity, while the third is a 1000-kw. unit. These units are placed crosswise to the length of the turbine room with their steam ends toward the boiler room. This arrangement facilitates the running of piping and also the running of leads from the generators to the switchboard. There is

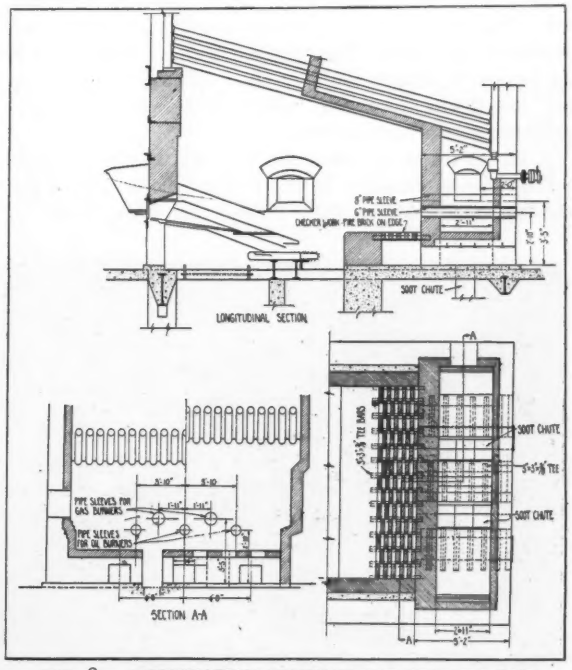


FIG. 8. COMBINATION FURNACE FOR OIL AND GAS

room for a fourth unit to be installed when the load reaches a point where the present machines will be unable to take care of it.

All turbines are supplied with steam at 180 lb. pressure and exhaust into a common low pressure system at 20 lb.

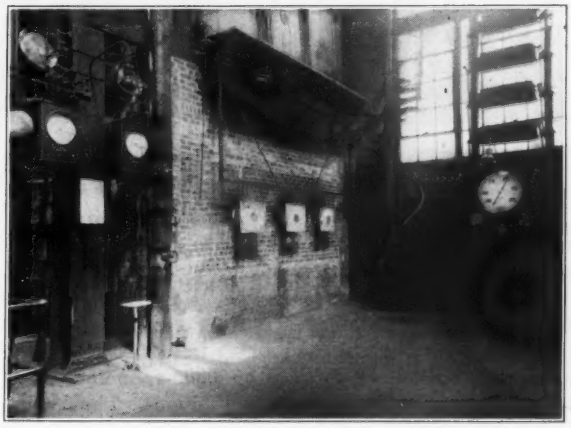


FIG. 10. FRONT WALL OF ONE OF THE OIL AND GAS FIRED FURNACES

This exhaust steam is then raised to approximately 600 deg. by means of Foster superheater in the oil still flues, and then passes on to the refinery, where it is used for various purposes.

Due to the entire absence of condensing equipment, the arrangement of equipment in the turbine room is com-

paratively simple. The oil switches for the generators and feeders are located in the basement, as shown in the cross section Fig. 3, while the control apparatus and direct current switching equipment is mounted on the switchboard in the turbine room.

At one end of the turbine room is located the pump room, or rather, the pump pit, for it is essentially a part of the turbine room, but located 16 ft. below the turbine floor. The five boiler feed pumps already referred to are installed in this pit. This arrangement is desirable not only because it affords plenty of light and air on the pump floor, but it also does away with unnecessary piping and equipment on the turbine floor.

A 15-ton traveling crane, made by the Northern Engineering Works, installed in the turbine room, is used for handling equipment on both turbine and pump floors.

FIG. 9. GENERAL VIEW IN BOILER ROOM

Electric power is supplied to about 400 squirrel cage induction motors, which range in size all the way from ½ to 150 hp. These motors have been carefully selected with respect to the power required by the machines, and the power factor is maintained at 80 per cent at all times. Transmission throughout the refinery is at 2300 v. and the current is used either directly by 2300-v. motors or is stepped down to 220 v. at various substations. The 2300-v. motors are used mainly in driving large pumps.

Conclusion

In concluding this article, we wish to extend credit to L. B. Van Leuven, Works Superintendent; H. A. Ross, Master Mechanic, and G. A. Ritchie, chief engineer of the power plant, whose assistance in the matter of supplying data and information made the preparation of this article possible.

Reducing Width of Stoker Front

PLANT expansion often calls for re-arrangement of mechanical equipment or its removal to new locations. In so adapting a piece of equipment to a certain previously allotted space, alteration of that equipment may be necessary. There are many cases in which such alterations have been materially expedited through the use of the oxy-acetylene process.

In one case the cast-iron front plates and stoker mechanism were, before alteration, part of a boiler furnace supplying steam to the power plant of a mill. It was necessary to move this furnace to a new location where the available space was narrower than the furnace. Of course this removal required that the boiler setting itself (the brick work) be torn down and rebuilt to fit the space available. This was easy but the width of the front plates caused trouble, until it was decided to reduce them with the aid of the oxy-acetylene process.

Accordingly, the cast-iron front plates were removed from the boiler setting and dismantled. Vertical strips of widths totaling the desired reduction in width of the whole casting were then cut with the cutting blowpipe from the centers of the front plate. Also, to take care of the reduction in width of each section, strips were cut from the doors. This left each front plate in two parts and each door in two parts.

The two halves of each piece were then lined up in temporary pre-heating furnaces and, after being carefully heated, were welded, using cast-iron welding rod and a good quality of cast-iron flux.—Oxy-Acetylene Tips.

Laboratory for the Central Station

FACTS AND FIGURES GATHERED THROUGH TESTS ARE NECESSARY FOR EFFICIENT OPERATION OF POWER PLANTS. BY JOHN D. MORGAN.

EVER GROWING installation and operating costs make it essential that unless current rates are raised all central stations must operate at a maximum point of efficiency. This maximum station efficiency is that efficiency for which the station was designed.

It is an impossible task to operate any central station at anywhere near its maximum point of efficiency, unless facts and figures concerning its operation are available to the operating department. The testing laboratory has rightly become the accepted means for supplying operating facts and figures and as such has become a necessary factor in the economical operation of central stations.

Few people question the value of a testing laboratory, but some claim the cost of installation and the consequent maintenance costs are not permissible expenditures. Those who do claim that the testing laboratory is an expensive medium through which to obtain economic operation, do so from a lack of proper cost data on the subject. To illustrate the cost entering into a testing laboratory as compared to that of a central station of 75,000 kw., let us consider the actual installation costs of such a station.

Table I shows the main subdivision of the power plant cost, both in regard to dollars, percentage and dollars per unit of power.

TABLE I. COSTS OF A 75,000-KW. POWER PLANT

Item	Amount	Cost per B.Hp.	Cost per Kw.	Per cent of total cost
Buildings	$1,046,516.00	$ 34.70	$13.92	24.3
Boiler, Superheater Stokers and Equip.	736,093.35	24.45	6.82	17.1
Main Units with Condensers and Pumps	1,243,139.64	41.35	16.57	28.8
Exciters	21,684.78	.72	.29	.5
Feed Water Heaters	18,000.33	.60	.24	.4
Piping	227,860.00	7.56	3.03	5.3
131 Panel Switch Board	120,242.60	3.99	1.60	2.8
Miscellaneous	999,455.30	33.31	13.30	23.1
Total Cost	$4,313,000.00	$142.82	$57.50	100.0

Now it is possible to equip a testing laboratory to do all the necessary work for a station of this size and also for the transmission and distribution system for the sum of $24,000 or about 0.56 of 1 per cent of the total cost of the station alone.

This sum of money when expended as in Table II will equip a real testing laboratory.

With the equipment listed, it is possible for the testing laboratory to perform the following duties:

1. To make acceptance tests on all new equipment. Such tests which show the failure of a piece of equipment to meet the guarantees, give the necessary data, to make the manufacturer replace the unit in question.

2. To test the meter standards used by the meter testers. To illustrate the value of this, a station of the size under discussion would in all probability have a total yearly output in kw.-hr. of somewhere near 267,500,000. Now if the testing laboratory keeps the testing meter standards 0.1 of 1 per cent more accurate than when no testing is done, the meters showing the current consumed by the customers would show a total of 267,500 kw.-hr. more; in other words, at a 9-cent rate, this would mean an increased revenue of $24,075 for the year. Also the testing and keeping in proper shape of meters tends toward a more friendly relation between consumers and the central station.

TABLE II. COSTS OF PRINCIPAL EQUIPMENT IN TESTING LABORATORY

Item	Cost	Per cent of total
Electrical and Mechanical Instruments for Testing	$8,610	36.2
Chemical and Coal Testing Instruments.	3,157	13.3
Mechanical Testing Equipment	3,100	13.0
Switchboard Testing Table	1,904	8.0
Tools and Miscellaneous	1,810	7.6
High Tension Test Equipment	1,770	7.4
Storage Batteries and Fixtures	1,269	5.4
Photometric Apparatus	1,200	5.0
Photographic Apparatus	778	3.3
Books	150	0.6

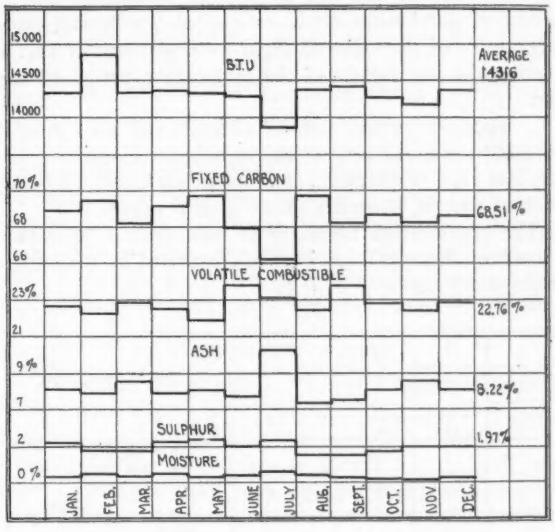


FIG. 1. AVERAGE MONTHLY COAL ANALYSES

3. To test all rubber goods used for electrical protection in this field, the possibility of accidents is lessened and as the result of less accidents, money will be directly saved, for the average jury nowaday, seems inclined to award a high rate of compensation in accidents of this kind.

4. To make photometric tests and to take photographs of all apparatus, scenes of accidents, safety devices, etc.

5. To test all materials purchased under specifications. This will prevent the substitution of inferior or unsuitable materials.

6. To test all water for boiler feed, and from these tests prepare the tables showing the amounts of water treatment, materials to be used, and the amount of water to be blown down from the boilers. Also to make daily tests on the condensed water from the surface condenser to indicate the amount of leakage of the circulating or cooling water into the condensed steam. This is of great importance when salt water is used for cooling water.

7. To test and repair all flow meters, gages, thermometers, and other mechanical and electrical gages and make insulator and cable tests. This formula is an important one, for upon the accuracy of the instruments, depends the general accurate determination of the economic operation of the plant.

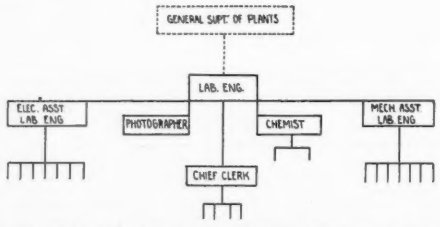


FIG. 2. ORGANIZATION CHART FOR TESTING LABORATORY

8. To make calorific tests of the coal used. This is a duty that is vital to economic operation for it determines the true value of the coal as well as determines a true method of purchasing B.t.u. as against purchasing coal. An example of the value of these tests is shown in Fig. 1 covering the test results of the coal over a period of one year.

9. To make periodic tests of all units and make special operating tests, and keep actual records showing the water rate, coal rate, evaporation, etc. As an example of keeping accurate records, there are shown several curves.

The organization necessary to man such a laboratory as has been described, can best be illustrated by the organization chart shown in Fig. 2.

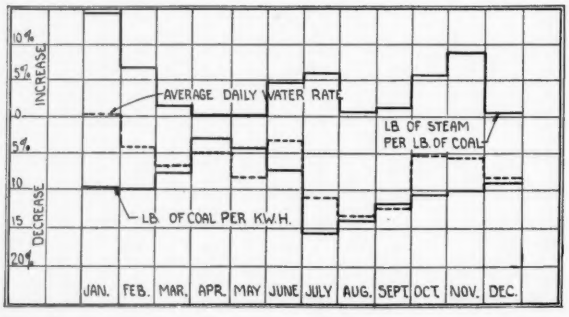


FIG. 3. SAVINGS EFFECTED BY SYSTEMATIC TESTING AS COMPARED WITH YEAR IN WHICH NO TESTING WAS DONE

There are a number of men who will question this organization chart, for they believe that the laboratory is part of the engineering department but I know of many places where this was originally done and later the laboratory was placed under the direction of the operating chief. This makes a better arrangement, for the laboratory does the greater bulk of their work for the operating department, and therefore, less friction and less expenses are incurred when they are under the direct supervision of the operating department.

It is a fact that the beneficial results that are accomplished by the laboratory cannot all be determined in an actual amount of money saved, yet it is possible to show that a large saving can be effected. In order to get a true idea of the saving, we must first of all take up the operating charges of the laboratory. These charges are shown in the table given below.

Capital charge 6 per cent on investment.	$ 1,440.00
Depreciation (10 yr.. expected life)....	1,919.00
Salary account	56,300.00
Operating supplies and expenses.....	7,500.00
TOTAL.....	$67,159.00

It may seem that this is a large yearly cost for a laboratory, but good men will not work for nothing and poor men are an expense at any price.

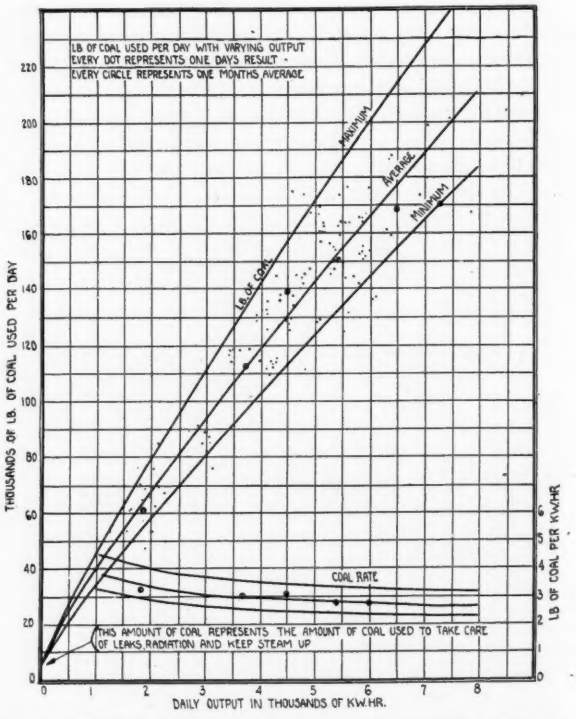

LB OF COAL USED PER DAY WITH VARYING OUTPUT
EVERY DOT REPRESENTS ONE DAYS RESULT -
EVERY CIRCLE REPRESENTS ONE MONTHS AVERAGE
MAXIMUM
AVERAGE
MINIMUM
LB. OF COAL
COAL RATE
THIS AMOUNT OF COAL REPRESENTS THE AMOUNT OF COAL USED TO TAKE CARE OF LEAKS, RADIATION AND KEEP STEAM UP
THOUSANDS OF LB. OF COAL USED PER DAY
LB OF COAL PER KW.HR.
DAILY OUTPUT IN THOUSANDS OF KW.HR.

FIG. 4. CHART KEPT BY TESTING LABORATORY UPON WHICH STANDARDS OF OPERATION MAY BE BASED

Let us consider the main cost of power generation for the size plant we have considered. The total cost of generation would be $1,477,364.00 or 0.5529 c. per kw.-hr. It can be assumed that the cost of coal would be about 80 per cent of this cost or about $1,180,000. Now, to get back the cost of the laboratory from savings in the coal consumption, would mean that the coal consumption would have to be reduced about 6 per cent, this as a rule can be done the first year the laboratory is in existence. An example of this is shown in Fig. 3. The succeeding years, however, cannot be as large, therefore the savings must be made by the keeping of meters in true conditions and making savings in other directions.

In a concrete way, if accurate records are kept, it will be found that the testing laboratory can pay real dividends on the investments and also furnish records that will assist in keeping the generating station and the distribution system at a high efficiency.

Efficiency in Oil Burning Installations---II*

SELECTION OF BURNERS AND AUXILIARY EQUIPMENT AND APPROVED OPERATING METHODS GOVERN LARGELY THE SUCCESS OF AN OIL BURNING SYSTEM. BY F. A. ROTHWELL

SELECTION of burners for any oil burning installation is as it rightfully should be, of major importance, for in the expenditure made for these pieces of equipment we are investing in something that must pay a return on the investment and it is in the careful summing up that we can determine just how such a piece of equipment can repay the principal with interest.

The fuel we are burning represents approximately 80 per cent of the cost for putting the energy onto the line and it is through these burners that we are to spend this 80 per cent. In the selection of burners it is not wise to let the initial cost enter into the transaction. If the work of burners is such that it will save considerable of the fuel bill, they are worth several times the original purchase price. The answer lies in "How much will they save?" and not, "How much do they cost?"

Fuel oil burners are divided into two distinct classes, mechanical atomizers and steam atomizers. Mechanical atomizers forcing the fuel oil through a small orifice at a high pressure of from 200 to 240 lb. Their great advantage lies in the fact that they do not use steam for atomization, and therefore conserve the steam output. For this reason they are most universally used in marine service where the utilization of steam for atomization is prohibitive. The steam atomizer has quite an advantage over the mechanical atomizer since it atomizes all grades of fuel without the interchanging of parts while the mechanical atomizer requires a change of tips with a change in the grade of fuel.

Steam atomizers are divided into two classes, one class being known as internal atomizers and the other known as external atomizers. The internal atomizers mix the fuel and steam in a chamber before it is expelled into the furnace. In the external atomizer the steam and fuel oil are discharged from two separate orifices, the oil orifice above that of the steam. The oil is forced out of its orifice and drops down on the jet of steam being discharged from the steam orifice. This steam jet carries the fuel into the furnace.

During the last 4 yr. it has been the writer's good fortune to conduct tests on burners of practically every design of the steam atomizing principle and in all cases it has been found that the internal atomizers were better suited for an unlimited service. The internal atomizer will atomize light and heavy fuel from 9 deg. Be. fluxed acid sludge to 27 deg. Be. gas oil. The requirements of a good burner are, (a) complete atomization, (b) easily installed and interchanged, (c) as few working parts as possible, (d) so constructed as to keep the fuel supply to tip from becoming overheated and being coked, (e) low maintenance.

The science of burner application is now reduced to such a basis that the manufacturer does not speak any more in terms of "pounds of water per pound of fuel" but more correctly "pounds of fuel per pound of atomizing steam," which means much more to the operating man. There is absolutely no logic in purchasing a burner that is guaranteed to evaporate 13.5 to 14.5 lb. of water per pound of fuel and at the same time consume 0.75 to 1.50 lb. of atomizing steam per pound of fuel in doing that work. It is much better to invest in a burner that will do the same work and use 50 to 70 per cent less steam in atomization. Worked out on a dollar and cents basis it will be found that this excessive steam really amounts to quite a few dollars. One 600-hp. boiler running at 150 per cent rating with an evaporation of 14 lb. and consuming 0.50 lb. of steam per pound of fuel fired, uses 1109 lb. of steam per hour for atomization. Another burner of the same kind operating under the same conditions consuming 1.50 lb. of steam per pound of fuel fired uses 3327 lb. of steam per hour for atomization, 2218 lb. per hr. more than the first boiler. With steam at 1 cent per hp. this means that the second boiler costs 64 cents per hr. more to operate than the first. This is $15.36 per 24-hr. day, enough to pay two operators.

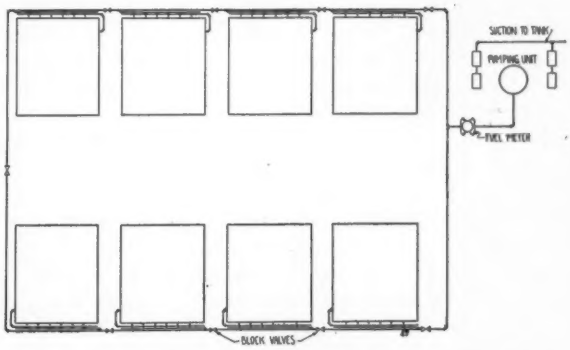


FIG. 3. RETURN OIL SUPPLY SYSTEM IS NOT NECESSARY TO SECURE BEST RESULTS

FUEL SUPPLY SYSTEM

Ordinarily the selection of the equipment for the delivery of the fuel oil to the burners is considered as a matter of opinion. There are several substantial pumping units available in the selection of which price only may enter. These pumping units are always supplied in duplicate. Two pumps to the unit allow for a good factor of safety. Attached to the unit as a permanent part is a heater, utilizing the exhaust from the fuel pumps for heating the fuel. These units also contain suction strainers, pressure regulators and air chambers to minimize the pulsations of the pumps. The location and installation of these units are governed to a great extent by the requirements of the boiler room; however, it may be stated that they should be installed as close to the fuel tank as possible in order to minimize the friction in the suction line and insure a positive suction head at all times. The fuel oil line from the heater, to the burners should be covered in order to conserve the heat supplied by the heater.

For the most effective atomization the viscosity of the fuel oil is reduced by heating. The heating of the oil accomplished two distinct things: it enables the viscous fuel to be handled more easily and reduces the amount of steam necessary to atomize a given amount of fuel. This

*This is the last section of Mr. Rothwell's article. The first, discussing furnace design and location of burners appeared on page 526 of the May 15 issue.

is due to the fact that the internal resistance of the oil is considerably reduced. The maximum temperature for this service is between 190 and 200 deg. F. It is unnecessary to heat the fuel oil above these temperatures since the viscosity is sufficiently reduced to enable excellent atomization and complete combustion. In practice it is found that there is a great tendency to overheat the oil. This would seem incredible but is explained by the Bureau of Mines bulletin, "Efficiency in the Use of Fuel Oils," that the capacity of a burner increases as the oil is heated to a certain temperature, determined by the viscosity and expansion relation, but with further increase of temperature the capacity steadily decreases.

In some instances it may be necessary to supply additional steam to the fuel in order to obtain the required temperature. This is usually done by installing a coil in the fuel oil supply tank. Extreme care should be used in using this coil as it is a point where large quantities of steam can easily be wasted. Just enough steam should be kept on this coil to give the heater in the pumping unity sufficiently hot fuel to enable it to raise the temperature between 190 and 200 deg. F.

On the suction of each pump there should be a good strainer. These strainers should be so constructed that they can be easily cleaned and the piping should be so arranged that one side of the unit can be completely dismantled while the opposite side is operating. The pressure regulator should maintain a constant pressure on the fuel line with but little deviation. These regulators are supplied with the pumping unit and should be, sturdy, easily accessible and easy to adjust. This unit should also be supplied with a thermometer and a reliable pressure gage for noting these conditions.

At the point where the fuel line leaves the pumping unit there should be a fuel meter for recording the fuel consumed. This meter should be entirely reliable and require no attention from the operating staff. A meter of the positive displacement piston type, is probably the most reliable and can be calibrated to the finest degree.

In the design of the fuel line it is not necessary to construct a return line for the circulation of the fuel but it is advisable to cover the fuel line with a good heat insulating material. This covering maintains practically 80 per cent of the sensible heat present in the fuel oil at the heater and insures a good hot fuel to the burners at the end of the fuel line. The capacity of the pumps and burners is variable and at any delivery the burners take the fuel as fast as the pump delivers it and if the ends of the fuel lines are arranged so that there are no "dead ends" no trouble will be experienced from the sluggishness of the fuel on the most remote ends of the line.

In a boiler room where the boilers are banked on both sides of the room it is advisable to have a loop as shown in Fig. 3, with the pumps discharging in both directions. With block valves in the line it is possible to isolate the entire system of any boiler for repairing without having to shut down or impairing the operation of the rest of the boiler room. In the design of the steam line to the burners there are two alternatives, one is to construct a steam header across the entire rear of the boilers and feed it from the main header or to construct an individual line from the outlet of the superheater of each boiler. The latter arrangement possesses the greater advantages due to the fact that it takes less piping and insures a minimum amount of condensation in the burner steam lines. A 1½ or 2-in. line is sufficient to supply steam to the four burners of a 600-hp. boiler.

Putting the Boiler on the Line

After the construction of a furnace comes a most important operation that more or less determines the life of the setting. This is the drying process. A furnace is dried preferably with a wood fire and for the following reasons: A wood fire does not give a direct concentrating heat and is more evenly distributed over all of the exposed surfaces of the furnace than would be the case with an oil fire. The temperature necessary to ignite fuel oil is sufficient to crack the damp surfaces and since the furnace is cold it is practically impossible to keep the fuel oil ignited with any degree of success. Constant going out of the flame is likely to result in the furnace becoming flooded with fuel oil unless it is constantly watched. A period of four to five days should be taken to dry thoroughly the entire setting. Firing should be started moderately and increased to such an extent that at the end of the period the boiler can be put under a full head of steam if so desired. It is impossible to over-emphasize the importance of completely drying out the brickwork. A little patience exercised in this process will repay itself in tight settings which are absolutely essential in order to obtain maximum furnace efficiency.

Among most firemen there is an opinion that the lighting of a fuel oil burner is a hazardous operation and liable to result in explosions or other disastrous catastrophe. On the other hand, the lighting of a fuel oil burner is quite simple and easily understood. The common error in the lighting of burners is allowing the steam to be admitted before the fuel oil is turned on. The natural function of the burner is so to apply the steam as to atomize the fuel oil. If the steam is turned on before the fuel oil the result is that the furnace is filled with atomized gases before the torch is applied. It requires no imagination to see the result of such procedure. There is in the fuel oil sufficient volatile matter to permit the fuel oil to be lighted without the aid of the steam. To light a burner correctly, first fashion a torch of waste or other such inflammable material and attach it to a rod of such length as to allow it to be placed in front of the burner tip. Saturate the waste with fuel oil and ignite from another furnace or fire-brand. Turn the fuel oil cock until the fuel begins to run from the tip, then apply the torch. When the fuel becomes ignited, turn on the steam supply slightly while still applying the torch. This is done so that if the steam extinguishes the flame at the end of the burner no gas will form without becoming ignited from the torch. After the fuel is once ignited, gradually increase the quantity of steam and fuel. As the temperature of the furnace rises with the increased rate of combustion and gradually reaches the maximum, adjust the burners and damper for proper operating conditions.

Dampers on each boiler should be so arranged that they are easily accessible and adjustable. They should be calibrated and supplied with a draft gage for determining the draft in front of the damper. By calibration it is meant to determine the actual effective area of the damper. It is accomplished in the following manner: With the damper in its extreme wide open position and the draft gage connected to the flue directly below the damper, gradually close the damper until it causes sufficient pressure, below it, to force the liquid in the gage to travel toward the zero

mark of the gage. It will be found that the damper can be moved several inches before the liquid in the gage begins to move; this area is known as ineffective area and in it we can move the damper all that is wished and yet not affect the conditions in the furnace or lower the stack temperature. At this point, where the damper causes the liquid to move, mark the position on the damper lever in such a place that it can be seen easily and it should be made permanent. In the same manner calibrate the closed position of the damper. From these two determined points it can be seen where the damper is operating and the firemen can be assured that it is not being operated in an unaffected area. In the manipulation of the damper lies the secret of success in firing fuel oil. With the damper, drafts, excess air and CO_2 are easily controlled. Good burners will operate a considerable length of time without readjustment and require attention only when increasing or decreasing the load of the boilers. In changing the firing rate of a burner it must not be forgotten that it is just as important to change the steam supply of the burner as it is to change the fuel oil supply. Too little atomizing steam causes smoke and an oil fired furnace should never smoke. Too much steam for atomization absorbs too much of the heat from the furnace and tends to dampen the fires. A too pronounced roar of the fires denotes that there is too much air entering the furnace and is detrimental to combustion. The proper appearance of the firebox is for the flame to extend the entire length of the furnace but not extend into the first pass. When viewed from the top, the first pass should be perfectly transparent. A long mellow gassy flame filling the entire firebox is quite the proper thing for high CO_2 and minimum stock losses. The necessary draft for the exit gases will be determined by the desired rating of the boiler, however, with any rate of combustion the draft of the furnace, for good operating conditions, will in all probability come between + 0.01 in. and — 0.01 in. of water. This draft is easily obtained and maintained through the medium of the damper.

The successful operation of any fuel burning system depends on consistent use of the knowledge gained through the constant association with the particular unit, or units, in which each individual is thrown in contact. This knowledge is gained by the process of reasoning, comparing and analyzing. Nothing is more valuable to the boiler room than the analytical mind and such can be used to the utmost advantage for gaining the maximum from each pound of fuel fired.

From the water and fuel meters reports can be obtained concerning the operation of each shift. These reports should be placed in a prominent position and the attention of the firemen called to them. They can contain unlimited information and should be a direct basis for bettering the conditions of operation as well as providing an insight into the work that is being done by the boiler room and the general attentiveness of the firemen. It is on these daily reminders that the firemen base their reasoning comparisons and analyses. The value of these daily shift reports is incalculable and it is through them that a followup system can determine just which operators are going ahead and which are standing still. This report should be considered a most important part of the operating schedule.

The day is past when the requirements for firemen were strong backs. The firing of fuel requires no strong backs, it necessitates intelligence and it will take intelligence to eliminate the alleged 25 per cent fuel waste. It is through the firemen, the men who must be intelligently trained, that we are to save something like 90 millions of dollars every year.

Fire Precautions for Pulverized Fuel Plants

PULVERIZING PLANT TO BE SEGREGATED; BUILDINGS TO BE KEPT CLEANED OF COAL DUST; MOTORS TO BE ENCLOSED AND MACHINERY GROUNDED TO AVOID SPARKS; CONVEYORS AND ELEVATORS TO BE ENCLOSED; FIRE EXTINGUISHERS TO BE PROVIDED IN EVERY ROOM

FORMULATION of Regulations for Fire Protection where dust hazard is involved has been taken up by the Committee on Dust Explosion Hazards of the National Fire Protection Association. This committee consists of twenty members, of whom eighteen have voted in favor of the regulations now presented for adoption by the Association, the other two not voting.

CLASSES OF SYSTEMS

Pulverized fuel systems involve the creation and possible liberation of combustible dust, unless properly designed, constructed and operated. They may be divided into three classes as follows: A.—Indirect, where the fuel is mixed with air at the point where used, involving storage bins at the point of consumption. B.—Direct, where the fuel, as a combustible mixture with air is blown by fans through large pipes, unused fuel being returned to the initial point. C.—Unit systems, where the fuel is pulverized near the point of use and delivered directly to the furnace by a fan or blower.

For the first two classes, pulverizing should preferably be done in a separate detached building, or in a separate room or floor, used for no other purpose and separated from the rest of the building by masonry walls and floors. Driers may be installed in boiler rooms of fire-resistive construction, cut off from the rest of the plant. Walls and floors of the pulverizer room should be unpierced, if possible, except by shafts, pipes and closed conveyors. Passage from the pulverizer room to the rest of the plant should be by outside passages or by masonry-enclosed, fire-resistive stairways. Indirect communication through separating walls may be permitted, the opening in the wall being closed by an automatic sliding door and that to the vestibule by an automatic-closing hinged door, both of fire-resisting construction.

Construction of the building should be such that there will be minimum lodgment of dust, that all parts may be easily cleaned of dust and that the force of an explosion will be relieved through skylight, windows or explosion doors. Surface not less than 10 per cent of the surface of the enclosing walls should be of light, incombustible material, preferably thin glass, so arranged that maximum distance from any part of the room to the glass is not greater than the least horizontal dimension of the room. Wired glass must be mounted in sash, so arranged as to swing out easily in case of an explosion.

Ventilation and Cleaning

Ventilation to the outer air is required for all parts of the pulverizer plant and apparatus is to be kept as nearly as possible in dust tight condition. Interior surfaces are to be cleaned frequently to prevent accumulation of dust and in such a manner that the dust will not be scattered. Blowing dust by compressed air is not recommended for walls and surfaces but is allowed for motors and other inaccessible places. Portable vacuum cleaners and air compressors should not be operated in the pulverizer room.

For pneumatic sweeping systems, nozzles and handles should be of non-sparking material such as fiber and all metal parts should be grounded to earth, preferably through the piping system. Dust entering the separator must not directly strike a metal surface and separation should be complete before the air goes to the exhauster, unless the exhauster discharges outside the building. Motor and separator should, preferably, be placed outside the pulverizer room.

Pulverizer mills must be safeguarded against fire and explosion hazard, power for driving being controlled at the mill and also remotely from a readily accessible point. All metal parts of the equipment and the belts should be electrically grounded. A magnetic separator of size to remove all tramp iron is to be provided and installed ahead of the pulverizer.

Electrical equipment is to conform to the National Electrical Code and all current for light and power is to be provided with remote control outside the pulverizer house.

Cloth type dust collectors are to be enclosed in tight metal or equivalent construction, vented to a safe point outside the building and grounded. All other types of collectors are to be of noncombustible material and located in the drying or pulverizing department or in a separate room.

Relief Vents

Safety relief vents should be provided at all pulverizers, at elevator heads, and at every storage bin. Vents at bins must have an area such that all the air can be discharged without building up pressure in the bin. Vents from pipes must be of at least the same area as the pipe and set at an angle of not more than 22½ deg. to the pipes from which they lead. They must lead as directly as possible to the outside air.

Blowers must be substantially installed with bearings entirely outside the blower casings or ducts and with connections to the ducts tight against leakage of fine dust.

Drying System

Drying must be separated from the pulverizing department by incombustible partitions and driers must not allow the products of combustion of the heating unit to come in contact with the fuel being dried except at a distance of half or more the length of the drier, never within 12 ft. of the fuel bed. Quantities of dried coal stored should be kept as small as possible and no dried, unground coal should be left in the bins for more than 4 hr. In case of a long shut down, the dried coal should be drawn out on the floor and cooled before being fed to the mill. Maximum amounts which may be stored are as follows: For coal entering the mill at 250 deg. F., 4 hr. supply; entering at 225 deg., 8 hr. supply; 200 deg., 12 hr. supply; 175 deg., 16 hr. supply; 150 deg., 18 hr. supply. This is for systems where the fuel is mixed with the air at the burner. Where the air is blown in with the fuel as a combustible mixture through large pipes, fuel must not be stored at above 150 deg. F. Every drier is to be of noncombustible construction, dust tight and with safety relief vent. A recording thermometer should be installed at the discharge end with the bulb as close as possible to the coal in the drier.

Fuel Lines

Pipe lines between mills, cyclones and bins should be of lap welded steel pipe, seamless steel tubing or butt welded steel sheet, No. 19 gage or thicker. Fittings should be of cast iron or No. 10 gage sheet steel, but welded. Cast-iron flanged fittings should conform to the 125-lb. American standard as to bolting. Welded steel fittings should have removable wearing plates at all points subject to abrasion. All joints are to be by means of standard pipe fittings or by flanges welded to the pipes, such flanges being at least ¼ in. thick and conforming to the 125-lb. standard as to bolting.

Pipe lines for pulverized coal must be of standard steel pipe and fittings equal to the 125-lb. American standard. They must be kept away from open lights or flames and from sources of radiated heat.

Storage Systems

Storage bins must be likewise located and as far from the furnace as consistent with operating requirements. Bins must be of noncombustible material, with smooth interior surface and of shape such that no material will be left in the corners when emptying. Joints should be riveted, caulked or welded and made dust tight. Bins should be tightly closed, except for vent openings, during operation, filled by means of air under pressure or from a fan and arranged so that no dust cloud will be raised by the transport air. A reliable device should indicate when the bin is in danger of overflowing, without exposing the contents of the bin and there should be no pressure in the bin except that from the weight of the fuel.

Screw conveyors should be driven from the discharge end and, where more than one screw is used, stoppage of the last screw in the series should automatically stop all the others, unless the junction points of the conveyors is placed outside the building.

Unless installed in conduit, electric lines for lighting or power must not be supported on storage bins, conveying machinery or fuel pipe lines.

Fuel Supply Lines

For Class B systems, carrying a combustible mixture of fuel and air to the burner, the distributing piping should be of metal, it and the fittings being designed to withstand safely the maximum working pressure that may be exerted. Each switch or branch line must have a suitable check, positive in operation and all piping fittings, joints, controls and valves must be of dust-tight construction.

Primary blowers must maintain a pressure greater than that from the secondary blower and motor circuits for both blowers must be arranged so that stoppage of either will result in stopping the other.

Main circulating lines must be free of baffles, valves or obstructions which might cause an accumulation of pulverized fuel. Cyclone separators are not to be placed

directly over fuel storage bins but should discharge returned fuel to the bin by gravity chute, screw conveyor or other safe method.

In unit systems, where the fuel is pulverized as used, the same precautions as to pulverizer, blower and fuel lines are required as for storage systems. When both crusher and pulverizer are used, the magnetic separator is to be placed between them. No single apparatus should supply more than two furnaces.

If volumetric capacity of the system, including housing of the mill, mixing chamber, fan and all the piping, is more than 100 cu. ft., the system must be provided with safety relief vent as for a storage system.

Each discharge pipe must have a positive shutoff and, if two discharge pipes from separate pulverizers deliver to the same furnace through one nozzle, there must be at the junction of the discharge pipes a valve which will automatically shut off the discharge pipe which is not in use. Every pipe which is vertical or nearly so, delivering fuel to a furnace through a down turn and every turn at an angle of more than 45 deg. must have a safety relief vent as heretofore described.

Operating Instructions

For plants using storage systems of either type, instruction cards must be posted in the pulverizing plant, the boiler plant and any other buildings where pulverized fuel is used. The instructions will call for supervision by competent foremen and operation by reliable workmen. Use of shavings or other similar light combustible material for starting fires is prohibited. Rotation of the drier must not be stopped while it contains a charge of fuel. If a plant has been idle for two days or more, storage bins must be carefully inspected before starting up. Manholes and inspection openings must be closed while fuel is being discharged into furnace bins. Damper in the drier chimney must be wide open when the fire is started. Bins and lines must not be hammered in a way that might cause leakage.

In systems of the second class, if the fuel supply line becomes clogged, the furnace should be cut off and the secondary air supply stopped. After the obstruction has been removed, thorough examination should be made before starting the fan to ensure that no smoldering particles of fuel are present. For the second class of systems, B, and for unit systems, all fuel supply lines should be blown clear of fuel when shutting down. After stopping an elevator or conveyor, it should be allowed to stand for 20 min., so that the dust may settle, before the casing is opened. Never open the casing while running.

Stationary lights and portables, (to be used around machinery only when not in operation), should have dust proof globes and wire guards. Inspection of machinery or of storage bins in operation should be made only by daylight or with hand flash lights. Of course, no open lights, torches or smoking should be allowed in any part of the crushing, drying or pulverizing plants.

Economical Operation of Condenser Pumps

Study of the Conditions Which Govern the Use of One or Two Circulating Pumps with Changes in Cooling Water Temperatures. By Chas. E. Colborn.

IT IS COMMONLY understood that with surface condensers it is desirable to reduce the quantity of circulating water during the winter months. The more modern power stations are now being designed so as to permit the variation of the circulating water flow. Some plants are using two cooling water pumps for each condenser, driven by constant speed motors, two of these pumps being operated during the summer months and only one during the winter months. In order to secure a close approximation to the most economical quantity of circulating water, two variable speed motor driven pumps can be used on each condenser.

As the temperature of the cooling water is lowered, less water is required. This may result in two conditions: 1. With the high vacuum resulting from low cooling water temperature, the reduction in turbine steam consumption per unit increase in vacuum becomes small in many turbines. 2. The higher the vacuum, the greater is the reduction in condensate temperatures per unit increase in vacuum. A point is sometimes reached at which the increase in cost of heating the condensate water becomes as great as the saving due to the operation at the improved vacuum. Before this point is reached, the volume of cooling water should be reduced.

Variations in the quantity of cooling water tend to affect the vacuum in two ways: 1. By varying the velocity of the water flow in the tubes. 2. By varying the mean circulating water temperature. The vacuum in a surface condenser is determined by the mean circulating water temperature and the mean temperature difference between the steam and water that is required to cause the transfer of heat. This mean temperature difference varies with the amount of heat to be transferred and the resistance to heat transfer. The resistance to heat transfer is affected by the presence of air on the steam sides of the tubes, by the amount the tube surfaces are fouled with slime or scale and by the velocity of the cooling water.

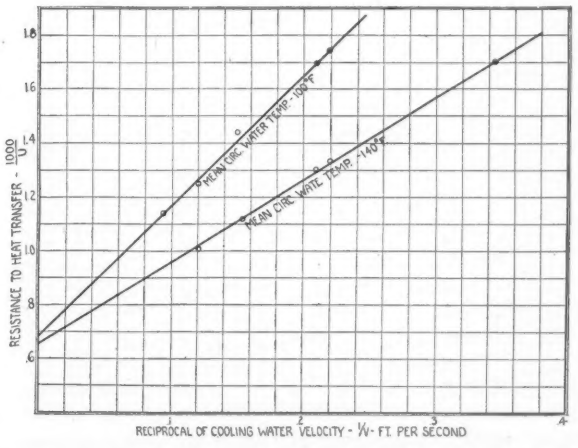

RESISTANCE TO HEAT TRANSFER - 1000/U
MEAN CIRC. WATER TEMP.-100°F
MEAN CIRC. WATE TEMP. -140°F
RECIPROCAL OF COOLING WATER VELOCITY - 1/V - FT. PER SECOND

FIG. 1. EFFECT OF WATER TEMPERATURE AND VELOCITY ON RESISTANCE TO HEAT TRANSFER

Figure 1 shows how the resistance to heat transfer varies with the velocity and temperature of the cooling water. The resistance here is the temperature difference required to cause the transfer of 1000 B.t.u. per hr. per

sq ft. It is thus equal to 1000/U in which U is the coefficient of heat transfer. In Fig. 1 the resistance is plotted against the reciprocal of the velocity of the cooling water.

Equation for Resistance to Heat Transfer

It has been found that the resistance when so plotted

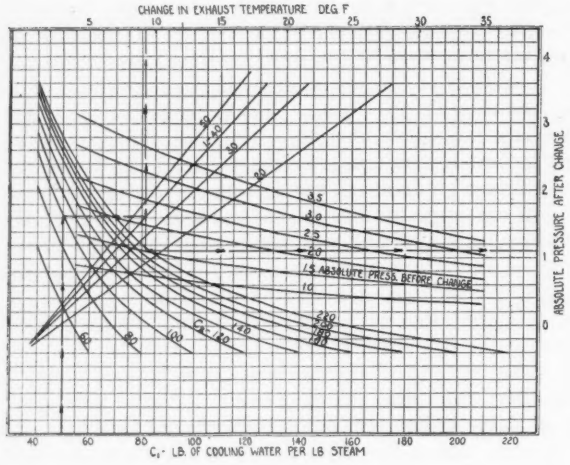

CHANGE IN EXHAUST TEMPERATURE DEG F
ABSOLUTE PRESSURE AFTER CHANGE
1.5 ABSOLUTE PRESS. BEFORE CHANGE
C₁ - LB. OF COOLING WATER PER LB STEAM

FIG. 2. CHART USED TO DETERMINE CHANGE IN EXHAUST TEMPERATURES AND ABSOLUTE PRESSURES

gives sensibly straight lines showing that the resistance can be expressed in an equation of the form

$$R = a + \frac{b}{V}$$

in which V is the water velocity and a and b are constants. The value of the constant a depends mainly upon the

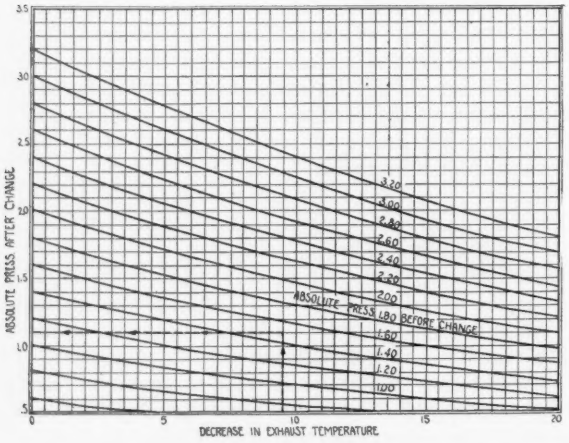


FIG. 3. EFFECT OF EXHAUST TEMPERATURE DECREASE UPON THE ABSOLUTE PRESSURE

resistance of the tube and attached slime and the resistance to heat transfer on the steam side of the tube. It is possible that the value of the constant a is also slightly affected by the temperature of the cooling water and of the water film on the steam side of the tube. Tests that the writer has made tend to show a higher value of this constant with lower water temperatures.

Value of the constant b varies greatly with the temperature of the cooling water. The test data so far available has not been complete and accurate enough to permit the accurate determination of the variation of the value of the constant b with water temperature. The values of resistance shown in the curves in Fig. 1 are, however, sufficiently correct for use in condenser calculations. These curves were plotted from tests made upon 1-in. No. 18 BWG new condenser tubes with an air free steam at approximately atmospheric pressure.

In a condenser the value of a is a great deal larger than shown here due to the fouling of the tubes and to the effects of air blanketing in parts of the condenser; however, no matter how great the value of the constant, the total resistance at a given temperature, is always reduced by the same amount with any given increase in the water velocity. By following the line in Fig. 1 corresponding to the mean cooling water temperature, the change in resistance for any given change in water velocity can be found.

Effect of a changed quantity of circulating water upon the arithmetic mean temperature is also easily calculated. Neglecting the effect of small changes in circulating water

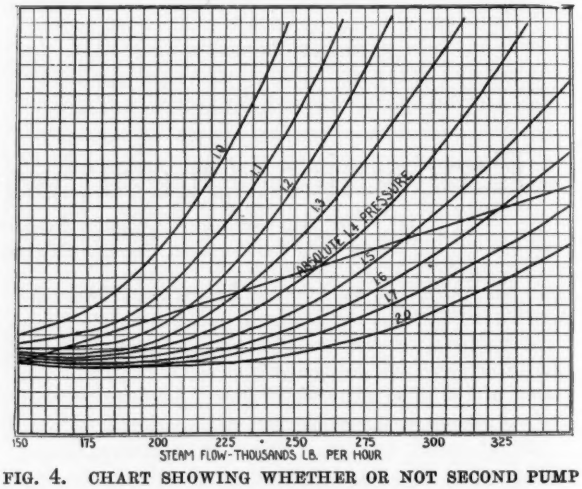


FIG. 4. CHART SHOWING WHETHER OR NOT SECOND PUMP SHOULD BE USED

temperature upon the heat transfer resistance, the total change in temperature of the steam caused by the change in cooling water volume will be equal to

$$\left(\frac{1}{C_1} - \frac{1}{C_2}\right) H \left(0.5 + \frac{2.0}{L}\right), \text{ in which}$$

C_1 and C_2 are respectively the pounds of circulating water per pound of steam condensed for the volume of circulating water before and after the change, H is the heat in B.t.u. given up by each pound of steam condensed and L is the length of the cooling water passes in feet.

Two-pass condensers with tubes 20 ft. long will have a value for L of 40 ft. Where the value of H cannot be otherwise determined it may be taken as 950. Figure 2 is a set of curves for the solution of the above equation. The heat given up by each pound of water has been assumed to be 940 B.t.u. The change in vacuum resulting from a gain in exhaust temperature can be found by referring to the steam tables or by using Fig. 3.

As an example of the use of the curves, suppose it were desired to know what vacuum would be had after increasing

the volume of circulating water in a certain condenser from 20,000 to 40,000 g.p.m. Suppose the turbine to be consuming 200,000 lb. steam per hr. and the vacuum to be 28.5 in. before the change. Take the length of the circulating water passes as 40 ft. The water volumes of 20,000 and 40,000 g.p.m. give respectively 50 and 100 lb. of water per pound of steam. Following the line dotted in Fig. 2 from the value of C obtained before the change vertically up to the value of C obtained after the change in circulating water volume and then horizontally from this point to the length of pass line and then up to the change in temperature gives a change in temperature of 9.4 deg. F. Following the line dotted in Fig. 3 from the value of the temperature change up to the 28.5-in. vacuum line and then to the right-hand margin shows the vacuum after the change to be 28.90 in. mercury.

When the change in vacuum is known, the change in turbine economy can be found by reference to the vacuum correction curves for the turbine. If the percentage increase in power necessary for pumping the increased volume of cooling water is greater than the percentage increase in turbine economy, the volume of the circulating water should, of course, not be increased.

Charts Can Be Drawn for Various Conditions

In cases where the condensers are equipped with two constant speed cooling water pumps, charts can be drawn by the use of the equation given in this article, that will show for all loads and vacuum conditions whether it is economical to operate one or two pumps. Figure 4 is such a chart prepared for a 32,000-sq. ft. condenser serving a 20,000-kw. turbine generator. The straight heavy line on this chart shows the change in exhaust temperatures that is caused by changing from one to two circulating water pumps. As the curve indicates, the change in temperature is directly proportional to the quantity of steam condensed. The curved lines are drawn so that they show, for different values of absolute pressure with two pumps in service, what increase in exhaust temperature is required to cause just sufficient reduction in turbine economy to equal the saving in power consumption due to the taking of the one pump out of service.

To draw these curves it is necessary to have data on the effect of vacuum changes in turbine economy. The change in vacuum should be known which is necessary to cause a change in turbine economy just equal to the extra power required to operate the second circulating pump as first calculated. Then by reference to the steam tables the vacuum change is converted to temperature change as plotted. It is further necessary, when drawing these curves, to determine the quantity of circulatory water and the power requirements both with one and two pumps in service. The quantity of circulatory water can be approximated by using the equation:

$$Q = \frac{S \times 950}{t \times 60 \times 8.3}$$

in which Q equals the water flow in gallons per minute, S equals the lb. of steam consumed per hr., and t equals the temperature rise of the cooling water.

If the change in exhaust temperature, that will be caused by shutting down a cooling water pump, is less than the temperature change that would be necessary to reduce the turbine efficiency by an amount equal to the power requirements for operating the second pump, it would be economical to take this pump out of service. In this case the point of intersection of the straight exhaust temperature line with the vertical steam flow line will be above the point at which the curve for the value of absolute pressure obtained, intersects with the vertical steam flow line. If the point of intersection of the vertical line for the steam being condensed with the curve for the absolute pressure obtaining comes at a point above the heavy straight line, the second pump should be kept in service.

Power Units at Wembley

Eight-Stage, Howden Impulse Turbine, General Electric Generator and Musgrave Surface Condenser

IN THE second turbo-generator unit, a combination of apparatus is found, to illustrate the practice of various makers. The unit has the same capacity as the others but differs in some details.

Running at 3000 r.p.m. and taking steam at 200 lb. and 212 deg. superheat, exhausting into 28 in. vacuum, the turbine, built by James Howden and Co., Ltd., drives a 1500-kw. generator supplied by the General Electric Co., Ltd., to deliver current at 3300 v., 50 cycle, three phase. The turbine is of straight impulse type, a single wheel to each of the eight stages.

These wheels are keyed to the shaft and held from axial motion by snap rings which fit into the shaft and the hubs of the wheels, the whole assemblage being clamped by nuts at the ends. Glands at the ends of the shaft are of the usual construction but steam seal is effected by lantern rings beyond the glands supplied with steam at slightly above atmospheric pressure.

Thrust is taken care of by a collar bearing at the left end of the left bearing. Oil is circulated by a worm gear-driven pump on the end of the shaft, this pump supplying low pressure for the bearings and high pressure for operating the governor. Governing is by a throttle valve worked by a servo-motor which, in turn, is controlled through a differential hydraulic relay valve operated by the centrifugal governor. Speed regulation is within 2 per cent under normal conditions. The main throttle is closed in case of overspeed by a governor located on the end of the shaft and overload is taken care of by a hand-operated valve at the high-pressure end of the casing.

This casing is in two parts, the high-pressure end of cast steel and the low-pressure end of cast iron. The parts are bolted together and the whole is bolted to and supported by the bearing pedestals, the high-pressure pedestal being free to move axially to take care of expansion. Casing and shaft are thus held in alinement.

Musgrave Condenser Equipment

Set crosswise of the turbine on the lower level and joined to it by a copper expansion sleeve is the Musgrave condenser. It is of surface type with cast-iron body and Admiralty mixture tubes. The shell is 4 ft. diam. by 10 ft. long, containing 2735 sq. ft. of cooling surface, sufficient to give 28 in. vacuum at 30-in. barometer with cooling

water at 75 deg. F. and condensing 20,000 lb. of steam an hour. The "Lonovane" circulating pump has a capacity of 2350 gal. of water an hour against 50 ft. total head and requires 51 hp. to drive it. It supplies the condenser, the oil cooler and the air cooler, though at times part of the condensate is passed through the air cooler, thus returning some of the heat to the boiler. Cooling water is pumped over cooling towers which accounts for the high head on the circulating pump.

Condensate is removed by a centrifugal pump which will handle 20,000 lb. of condensate an hour at 35 ft. head, requiring 2.5 hp. to drive it. These pumps are in line, connected by flexible couplings and are driven by a 61-hp. motor of slip ring type running at 1450 r.p.m. and controlled by a liquid starter.

Some Generator Details

Laminations of the stator are held in a box casting which is bored to receive them and are clamped by stout end plates so that no bolts pass through the laminations. Longitudinal ribs of the casings have keys dovetailed into the ribs and the stampings to prevent shifting of the latter.

Micanite insulating tubes are moulded onto the coils which are pushed through the slots from one end and the ends of the coils then bent up, one conductor at a time, so that it is made certain that insulation of slot and conductors is in perfect condition. Heavy clamps are arranged all around the windings to prevent shifting of the coils in case of short circuit strain.

Rotor coils are shaped, then placed in the slots and the slots closed by metal wedges. Ends of the windings are

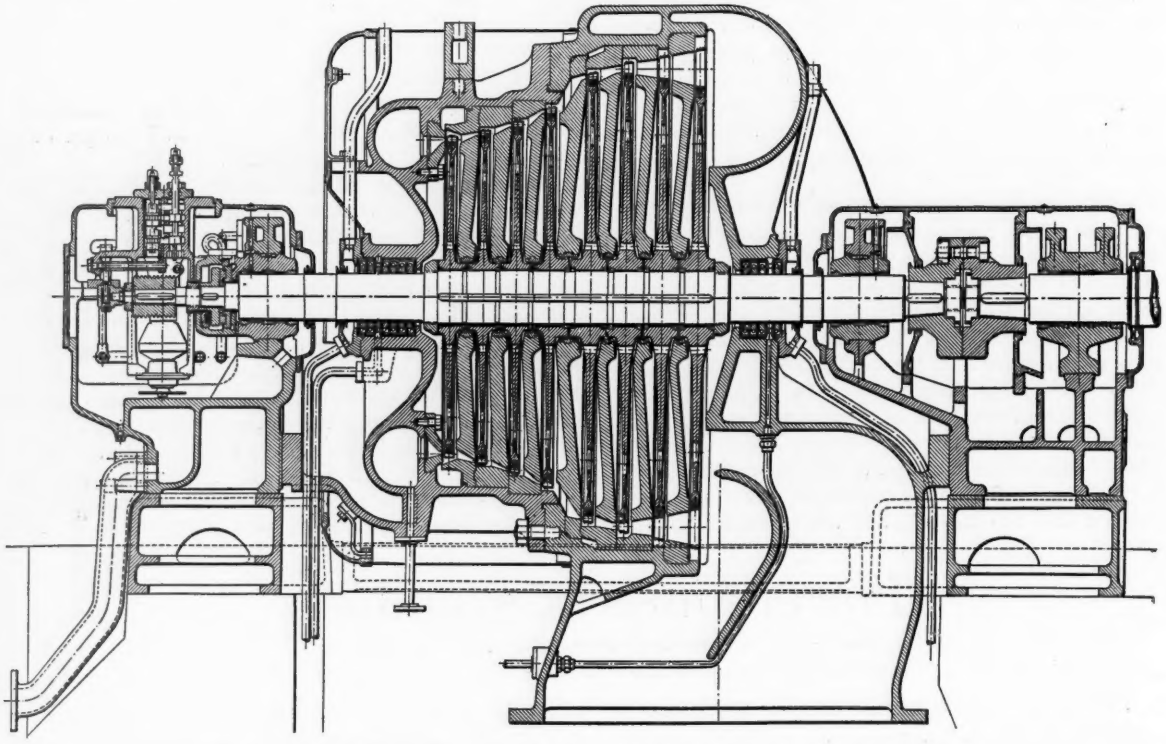


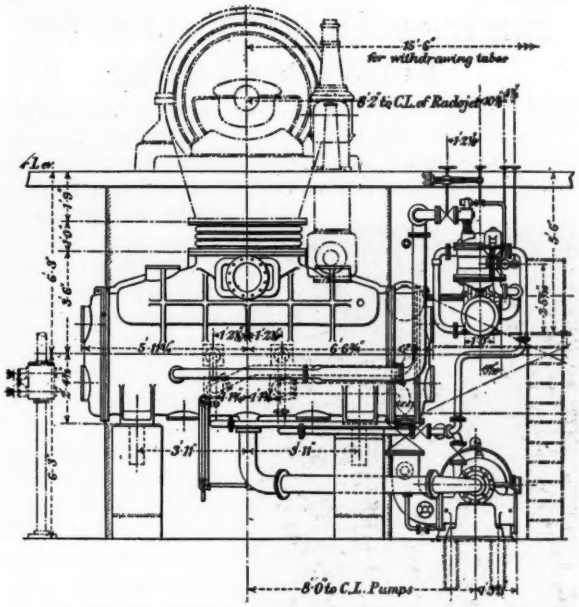
FIG. 1. IN THE HOWDEN TURBINE THE CASING IS CARRIED BY THE PEDESTALS

Air and vapors are withdrawn by Radojet extractors installed in duplicate for emergency and quick starting. Steam for the first stage of extraction is taken from the main steam inlet to the group of nozzles seen at the top right of Fig. 3. These jets draw the air through the air suction and force it through the throat pipe into the intercondenser where steam and vapor are condensed. From this the air and non-condensible vapors are drawn to the second stage. Live steam issues from the second ejector in a flat sheet, giving large surface for entraining air, which is compressed to atmospheric pressure in the annular diffuser, as seen at the left in Fig. 3, the mixture being carried into the discharge belt and removed at the bottom. Adjustment of the second ejector can be made while in operation by altering the position of the deflector plate at the right of the jet. Final discharge is to a feed-water heater and cooling of that and the intercondenser is by condensate, so that all heat is conserved.

covered by steel shrouds, lightly shrunk on and held to the rotor at one end and to the shaft at the other. In this way, the windings are completely boxed in so as to be protected from injury. Ventilation of the rotor is secured by air drawn by fan action into ducts under the coils and discharged by special ducts through the stator laminations. Fans at the ends of the rotor draw air through channels in the end shields and force it around the ends of the stator coils, thence to the air delivery belt around the casing and through vents into the air gap whence it flows out through ducts in the stator laminations.

Outside the outboard bearing is an exciter, having commutating poles, exciting current being carried to the rotor by means of steel slip rings from which leads are carried to the rotor windings by leads sunk in grooves in the shaft and protected by key-shaped covers.

As already stated, the three generating units are of the same size and work under the same conditions of pres-



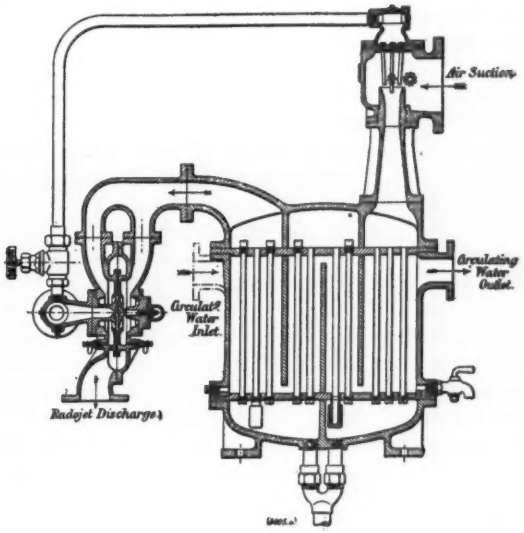


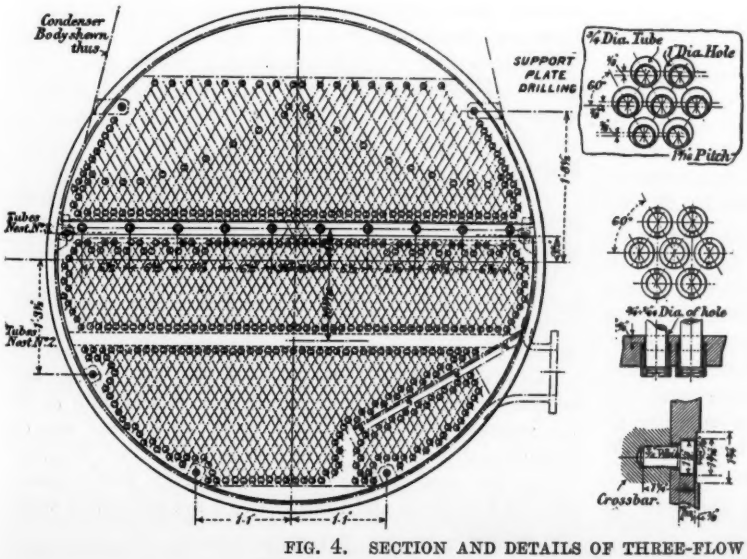
FIG. 2. CONDENSER EQUIPMENT IS BELOW THE TURBINE WITH AN AIR EJECTOR AND PUMPS AT ONE SIDE
FIG. 3. IN THE RADOJET EXTRACTOR AN INTERCONDENSER AND A SECOND-STAGE RADIAL JET ARE USED

sure, vacuum and superheat. All three deliver into common busses, but the three are independently controlled and each has its individual condensing equipment.

Third Generating Set

This third set is of English Electric Co., Ltd. make and has eight stages, the first wheel being of compound-velocity type and the other single impulse type. The turbine casing, cast steel on the high-pressure end and cast iron on the low pressure section, is split horizontally, with guide nozzle diaphragms cast in halves and held to the casing by set screws. By this construction, the top half of the casing can be unbolted and taken off without breaking pipe connections.

Details are of the usual types; brass inset labyrinth joints between the bore of the nozzle diaphragms and the hubs of the wheels; wheels mounted to the shaft by split rings similar to piston rings; glands at high and low-pressure ends of carbon ring type with steam seals; worm-gear-driven governor controlling the throttle valve spindles by means of an oil relay gear; eccentric ring emergency governor which trips a trigger on 10 per cent overspeed and closes both throttle and stop valves. Oil is circulated by a gear-type main oil pump which is driven from the main turbine shaft and provides pressure for the oil relay gear and, through a reducing valve, the oil for the lubricating system. The oil is drawn from a reservoir at the end of the turbine bedplate, is forced through a cooler, similar in



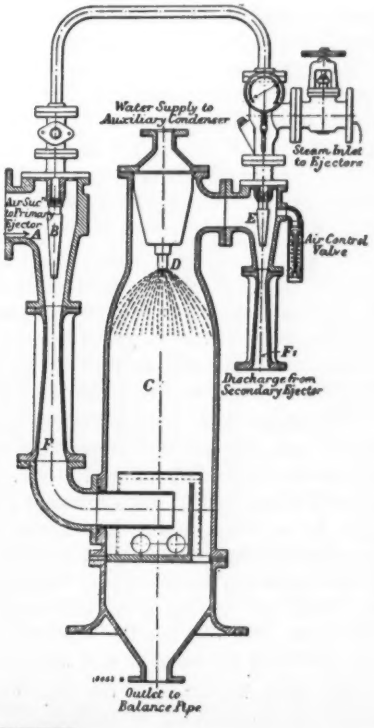

Water Supply to Auxiliary Condenser
Steam Inlet to Ejectors
Air Suc. to Primary Ejector
Air Control Valve
Discharge from Secondary Ejector
Outlet to Balance Pipe

FIG. 4. SECTION AND DETAILS OF THREE-FLOW CONDENSER
FIG. 5. EJECTAIR USES TWO NOZZLES AND WATER SPRAY CHAMBER

design to a condenser, to the bearings and flows back to the reservoir through strainers which can be cleaned while the turbine is running. An auxiliary oil pump, driven by a small steam turbine, is cut into operation automatically, if the pressure falls below a predetermined value, and this pump is also used for starting up to give pressure until the turbine is up to speed.

Condenser features are worthy of note. The condenser was designed for 2000-kw. turbine capacity, so is somewhat large for the unit. It rates to handle 27,400 lb. of steam an hour and can take care of a maximum of 36,000 lb. an hour. It has 3550 sq. ft. of cooling surface to give 28.25 in. vacuum with barometer at 30 in. and with cooling water at 75 deg. F. As shown in Fig. 4, it is divided into three parts to give three passages of steam through the shell and is so proportioned that area for steam flow decreases gradually from top to bottom, spite of the cylindrical shell. Wide spacing of the tubes in the upper section and large steam inlet are special features, characteristic of the English Electric Co.'s design. In the lowest section is a baffle which separates a group of tubes over which the non-condensible gases flow before leaving the condenser so that they are separated from the water vapor and cooled before going to the air extractor.

To remove these gases, a Hick Breguet Ejectair is used with capacity of 30 lb. of air an hour, maintaining a vacuum of 28.25 in. The device will use 320 lb. of steam an hour when doing this work. Two single nozzle steam jets are employed with a condensing chamber between them. Air is drawn from the main condenser through the opening A by the first jet and discharged into the chamber C, where it is cooled and the steam from the first jet condensed by a water spray D, the water used being condensate. This is possible because the vacuum in the chamber is some 4 in. less than that in the main condenser. Discharge of water from this chamber is from the bottom by means of a balance pipe to the suction side of the condensate pump, the head in the pipe being sufficient to balance the difference in vacuum between the chamber and the condenser. Air from the chamber is drawn off by a second jet which discharges to a feed-water heater through which the condensate passes, so that all the heat is reclaimed. An air control or stabilizer valve, shown at the right, comes into action at very light loads when vacuum in the chamber would otherwise be too high to ensure satisfactory operation of the second jet.

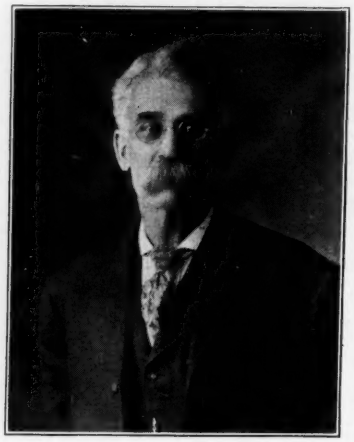
For heating the feed water, the heater is designed to handle 2740 gal. of water an hour at 92 deg. F., condensing 190 lb. of steam at 16. lb. absolute pressure and raising the temperature of the water 6.6 deg. F. At this capacity, the head resistance will be 2.14 ft., or at a maximum of 3600 gal. of water an hour, the head will be 3.7 ft.

Circulating and condensate pumps are separately mounted and driven. The former has inlet and outlet 14 in. diameter and will handle 2760 gal. of water a minute against a head of 52 ft. when running at 1450 r.p.m. It is driven by a 70-hp. motor, has double entrance impeller, ring oiled bearings, collar thrust bearing and stuffing boxes with soft packing, water sealed. The condensate pump has 4-in. inlet and outlet, is of two-stage type running at 1450 r.p.m. and will handle 43,000 lb. of condensate an hour under 28 in. vacuum and against head of 30 ft.

Data and illustrations for this article are used by courtesy of Engineering of London.

Engineer Holds One Job for Forty-five Years

IN THE year 1876 five 75-hp. heating boilers were installed in the state capitol building at Lansing, Mich. Three years later, Addison Childs applied for and was given a job as boiler room helper, his pay being $2 a day which was considered a top notch wage in 1879. Within a short time he had been made assistant engineer, in which capacity he served for 20 yr. For the past 25 yr. he has been chief engineer.



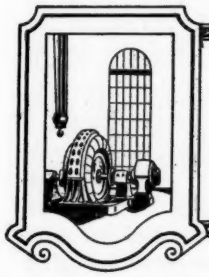
Records of the boilers are as remarkable as that of Engineer Childs. When originally installed, three boilers were placed at the east end of the building and two boilers were placed at the opposite end of the building. In 1884 the sixth unit was installed. Although the load imposed on these boilers was primarily that of heating the building, it was necessary at times to raise the boiler pressure in order to operate pumps used for the building water supply. These boilers were made by the Walworth Manufacturing Co., of Boston, Mass., in the year 1876. They are of the horizontal return tubular type and were equipped with shaking grates. Each boiler is still equipped with its original Crosby steam gage.

For the first few years of operation, anthracite coal was burned; of late years, the plant has turned to the use of bituminous coal. Once a year, when the heating load was off, each boiler was thoroughly cleaned, both inside and out. Practice varied as to the method of laying up the idle boilers. Some seasons they were dried out and left open to the atmosphere and other summers they were filled with water.

As a precautionary measure, units Nos. 1, 2 and 3 were completely retubed in 1920. Up to that time but 3 tubes had been replaced in unit No. 1, 18 tubes had been replaced in unit No. 2 and 5 tubes had been put in unit No. 3. Unit No. 4 has had no tubes replaced since its installation in 1884. Sixteen new tubes have been put in unit No. 5 and 8 tubes have been replaced in the sixth boiler.

When the plant was first put in operation, it was the practice to cut off one boiler and raise its pressure to 30 or 40 lb. in order to operate steam pumps at the river. These pumps discharged into a ground level cistern. In the boiler room are two Geo. F. Blake Mfg. Co., direct acting steam pumps. The steam end of each pump is 12 in. in diameter and the water end 4 in. in diameter.

Notwithstanding that these boilers have been used essentially for heating purposes and have been laid up for the summer periods, their record of service and maintenance is unusual. The uninterrupted care which Engineer Childs has used in the operation of these boilers speaks well for his ability and the quality of the equipment which was installed.



ELECTRICAL MACHINERY FOR LIGHT AND POWER

Review of Developments in Electrical Apparatus

AN ABSTRACT OF THE 1924 REPORT OF THE ELECTRICAL APPARATUS COMMITTEE OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION

IN REVIEWING DEVELOPMENTS in the electrical field throughout the year it is difficult to classify developments in any particular order of importance. Advances have been made in all branches of the field and it would not be correct to say that any one development was of greater outstanding importance than another due to the fact that no direct relation exists between them. It will be convenient therefore to begin our discussion with those developments relating to the generating stations since this is the first step in the process of transforming the heat energy of the coal into electric power.

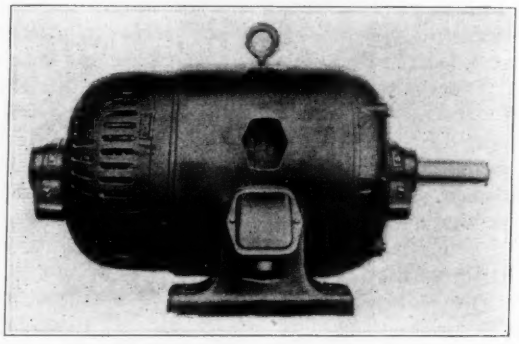


FIG. 1. THE FYNN-WEICHSEL MOTOR

There is at the present time a decided trend toward heating of feed by bleeding steam from various stages of the main units. This has had a decided bearing upon the development of motors and control equipment for it has brought about a great demand for electrically driven auxiliaries. It has also resulted in the development of new methods for generating electric power for auxiliary driving purposes.

During the past year a number of companies have purchased the main turbo-alternator with an auxiliary generator on the main shaft for supplying energy to essential auxiliaries. This is a new idea and is a compromise between the separately driven house turbo-generator and taking the entire supply from the main bus. These auxiliary generators are usually 2300 v. 60 cycle machines and are placed on the main unit shaft in such a manner as to prevent the possibility of their being overloaded when in parallel with transformers supplied from the main bus. The general practice is to operate with the essential auxiliaries supplied from the shaft alternator; parallel operation being limited to periods required for transfer of load. In some cases this auxiliary generator is a direct current machine supplying both the current for essential auxiliaries and that required for excitation of the main units.

In regard to the methods of starting squirrel cage induction motors driving auxiliaries, the practice of starting under full voltage has proved quite successful. Experience has indicated that wherever the source of energy supply is of ample capacity there is little risk in this practice and much desirable simplification of connections and control. Manufacturers request that where it is intended to start motors regularly at full voltage specific approval be obtained, as this practice may be undesirable with large high speed motors.

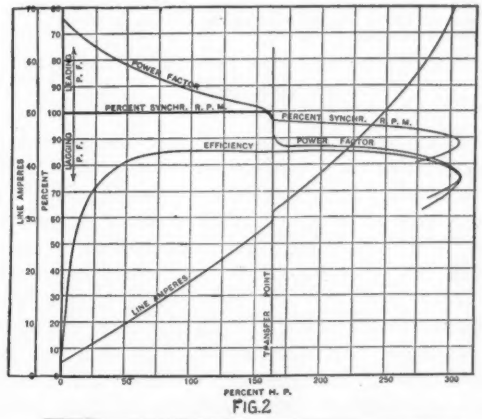


FIG. 2

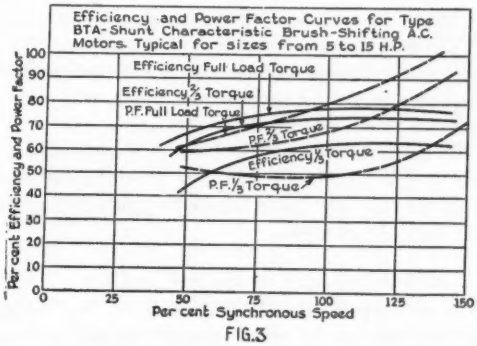

Efficiency and Power Factor Curves for Type BTA-Shunt Characteristic Brush-Shifting A.C. Motors. Typical for sizes from 5 to 15 H.P.
Efficiency Full Load Torque
Efficiency 2/3 Torque
P.F. Full Load Torque
P.F. 2/3 Torque
Efficiency 1/3 Torque
P.F. 1/3 Torque
Per cent Efficiency and Power Factor
Per cent Synchronous Speed

FIG. 3

FIG. 2. LOAD CHARACTERISTICS OF THE FYNN-WEICHSEL MOTOR ADJUSTED TO OPERATE IN PARALLEL WITH INDUCTION MOTORS

FIG. 3. EFFICIENCY AND POWER FACTOR CURVES FOR SHUNT CHARACTERISTIC BRUSH SHIFTING A. C. MOTOR

Fire Fighting Equipment for Generators

Further recommendations have been made in regard to the methods of insuring fire protection for generators. The final form of these recommendations is as follows:

(1) All turbo-generators of the horizontal air-cooled type, regardless of size, to be provided with openings in the outer casings, such openings to be covered by quickly removable plates through which quickly accessible hose streams can be injected into the windings.

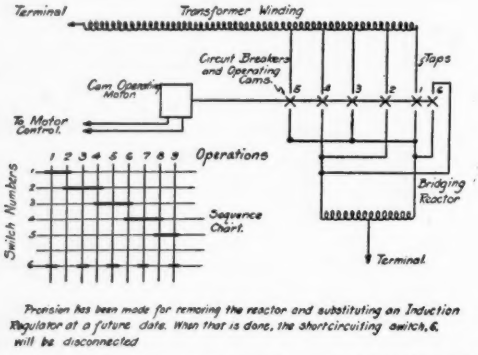

Terminal
Transformer Winding
Circuit Breakers and Operating Cams
Taps
Cam Operating Motor
To Motor Control
Operations
Switch Numbers
Sequence Chart
Bridging Reactor
Terminal
Provision has been made for removing the reactor and substituting an Induction Regulator at a future date. When that is done, the short-circuiting switch, 6, will be disconnected

FIG. 4. WESTINGHOUSE STEP TYPE TAP CHANGES FOR TRANSFORMERS

(2) Where space between the outer casings and the windings is sufficient, a suitable apparatus should be permanently installed for extinguishing generator fires. This equipment may be of (a) internal water or steam spray type, or (b) the type using steam application in the air duct below the generator, or (c) the type using a satisfactory inert gas. Any type using steam should be designed to avoid high temperature steam impinging directly on the windings. All systems should be connected to a constant source of extinguishing medium, and arranged for quick application. Care should be taken to prevent water or steam leaking into the generator by installing proper valves and drip.

(3) When conditions will permit, a well-designed balanced relay system should be provided which will electrically disconnect the generator from service.

(4) Means should be provided for closing dampers in the air ducts when such procedure is favorable, although recognizing the fact that there can be no guarantee against leakage around the dampers.

Generator Power Factor Rating

Considerable operating difficulties have been experienced in the past on 60-cycle systems because in many cases the system power factor was considerably below the power factor rating of the principal turbo-generators and there has been a decided tendency to demand generators of lower power factor rating. This subject has received much consideration in the past year and the following unanimous action was taken in April, 1923, by the Electrical Apparatus Committee:

It is the sense of the electrical apparatus committee (1) That the Prime Movers Committee and the Edison Association Committee should arrange for any desired overload capacity in the steam turbine, but not tie it up with generator power factor rating.

(2) That standard 60-cycle generators should be rated at 80 per cent power factor, which would then be entirely capable of being used at higher power factors within the kv.a. rated capacity up to the maximum available kw. of the turbine.

(3) That standard 25-cycle generators should be rated at 100 per cent power factor, except where and when lower power factors are desired that they should be so specified.

At the request of one of the largest turbo-generator manufacturers, who pointed out the design difficulties in obtaining 80 per cent power factor as against 85 per cent, the 1923 recommendations were reconsidered but after discussion no change was deemed desirable.

Considerable interest has been manifested in the possibility of development of couplings for turbo-generators which could be rapidly disconnected in case of turbine

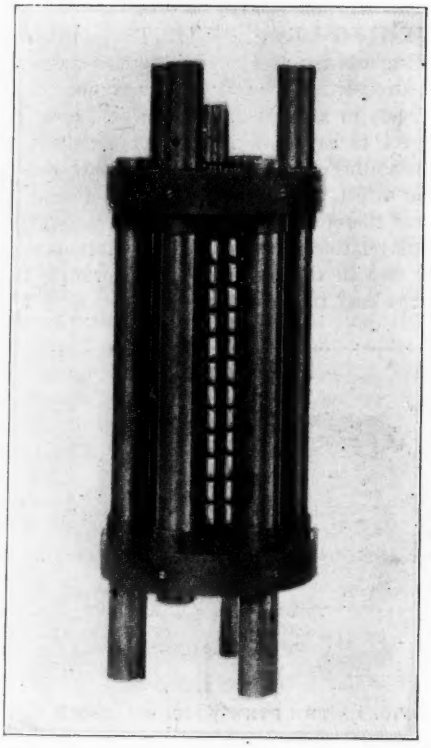


FIG. 5. OPERATING MECHANISM OF G. E. CRAB TYPE RATIO ADJUSTER

trouble, thus permitting the use of the generator as a synchronous condenser for power factor correction while the turbine was out of commission. The matter is largely of a mechanical nature. It was brought out that all four-bearing turbo-generator units can be disconnected in from three to four hours, but that it is necessary to arrange for lubrication and starting of the generator. It has been suggested to manufacturers that suitable means be made available to split the oil system on turbo-generators easily in order to be able to run the generator with the main coupling disconnected. Certain three-bearing machines cannot be operated in this manner.

Unfavorable experience with water spray air washers has been reported by two larger companies due to low temperature. The trouble was due to the freezing up of the eliminator plates, resulting in the cutting off of the air supply to the generators. In one case the armature on the alternator was destroyed.

Substantial progress is being made by manufacturers toward the production of apparatus which will register abnormal system conditions and will be sufficiently inexpensive to permit of fairly widespread application of operating systems. This apparatus promises automatic registration in the event of the materializing of transient conditions now considered to be influential as a cause or effect of system disturbances of greater magnitude.

Electric Motors

Motor rules underwent revision last year and no general demand for further modifications has been indicated up to this time. Practically all standard lines of motors meet the prescribed conditions.

It has been brought out during the year that operating companies should insist upon having starting equipment for motors set on the lowest possible tap which will give satisfactory starting conditions. In this way it is possible materially to limit the starting inrushes on the installation.

The outstanding development of the year is the high power factor Fynn-Weichsel motor, a new type of constant speed alternating current motor brought out by the Wagner Electric Corporation, which combines a number of the characteristics of both the synchronous and slip ring induction type of motors. The complete motor, Fig. 1, consists of a stator with starting and operating windings and a rotor with two windings carrying load and exciting currents. The windings of the rotor are connected to a commutator and to slip rings of the usual construction. Brushes bearing upon the commutator suitably interconnect stator and rotor windings. Starting up is accomplished in the same manner as with the slip ring motor. When heavily overloaded the machine drops out of step and operates with induction motor characteristics. When the excess overload is removed the motor again operates at synchronous speed. Figure 2 shows the performance of this motor under various load conditions.

A 3-phase, adjustable speed, brush shifting motor has been developed by the General Electric Company, with speed characteristics similar to those of direct current shunt motor. This type of motor is available in sizes from 5 to 50 hp. for 220, 440 or 550 volts, 60 cycles. Figure 3 shows efficiency and power factor curves at various speeds.

Oil Circuit Breaker Switching Equipment

During the past year there has been considerable further discussion with regard to the proposed new definitions of duty cycle and complete agreement has now been reached as to these definitions by the Electrical Apparatus Committee of the N. E. L. A., Protective Devices Committee of the A. I. E. E. and the Electric Power Club representing the manufacturers.

The approved definitions are as follows:

First: Interrupting rating is based upon the highest RMS current at normal voltage which the oil circuit breaker can interrupt under the operating duty specified. The value of the current shall be taken during the first half cycle of arc between contacts during the opening stroke.

Second: Operating duty shall consist of a definite number of unit operating cycles at stated intervals.

Third: Each unit operating cycle shall consist of closing the circuit breaker followed immediately by the opening of the breaker, i. e., without purposely delayed action.

Fourth: The breaker shall perform its rated operating duty without emitting flame.

The condition of the circuit breaker at the end of any operating duty within its rating shall be:

(a) Mechanical

Inspection shall show the breaker to be substantially in the same mechanical condition as at the beginning.

(b) Electrical

Inspection shall show the main current carrying parts of the circuit breaker to be in substantially the same condition as at the beginning. However, the interrupting ability of the circuit breaker may be materially reduced.

It is not to be inferred from the above that the breaker may be reclosed after the completion of the operating duty without making inspection and repair where necessary.

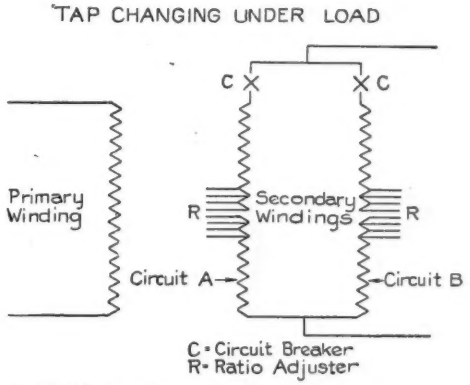


FIG. 6. CONNECTIONS FOR TAP CHANGING UNDER LOAD. G. E. CO. METHOD

Fifth: The standard operating duty shall consist of two unit operating cycles at a two minute interval.

Transformers

Experience of several large operating companies with temperature indicating devices has proven that these devices save many times their cost by permitting smaller transformer capacity per kv.a. of peak, by reducing transformer failures and in generally improving the quality of service.

Orders received by manufacturers apparently indicate that the oil conservator principle has not lessened in favor. Some fear has been expressed, however, regarding the performance of conservators in cold climates due to the congealing of or sluggish flow of oil in connecting pipe between conservator and transformer tanks. Last year the manufacturers stated they were in general increasing the size of this pipe. Of course, there is probably a limit to the reasonable size of this pipe because of the possibility of convection currents in it, thus partially defeating the purpose of the conservator.

For large transformers little doubt now exists as to the possible value of relief diaphragms, loose manhole covers, etc., as a safety valve to relieve against sudden pressure which may be set up within the transformer under arcing, short circuiting, etc. Relief diaphragms of ample

size should be installed in connection with oil conservators. Glass or micarta is the material now generally employed for these relief diaphragms. Metal should not be used.

Transformer Cooling

Transformer development during recent years has involved the production of self-cooled transformers in some very large sizes. Water for cooling is frequently expensive, or hard to get, or needs to be recooled by cooling tower, spray pond or the like and in cold climates there is always a possibility of freezing of the circulating system.

Space requirement and general bulkiness, proportions of investment represented by the radiators and their contained oil, and possible fire hazard through the presence of large quantities of oil in the tank and radiators are beginning to lead towards research into other methods of cooling, notably circulating oil through radiators of the automobile type, air being blown through these radiators by auxiliary power driven blowers or fans.

An unusual method of transformer cooling is used by the Southern California Edison Co. at one of its substations, located in a congested part of the city where ground space is at a premium. The building is several stories high and the transformers are located in the base-

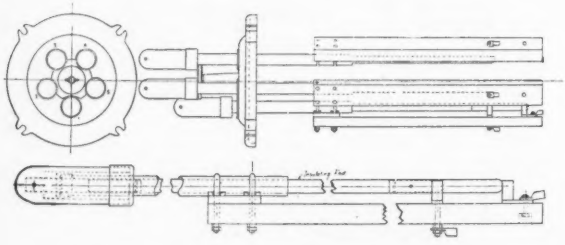


FIG. 7. PACKARD TAP CHANGING DEVICE

ment, but the radiators used for cooling are on the roof so that advantage may be taken of the breeze blowing from the ocean. This station has been in operation for several months and the method of transformer cooling has been sufficiently satisfactory to justify the installation of another transformer bank, using the same method of cooling.

Great interest has been displayed during the past year in methods for changing taps or voltage ratios of transformers while under load. The methods developed vary with different manufacturers. The Westinghouse Electric and Manufacturing Co.'s method for doing it is shown in Fig. 4. The transformer tap leads are brought outside of the tank and connected to breakers mechanically operated from a cam shaft. The scheme consists essentially of a cam operated mechanism for connecting reactors successively across the various taps. The mid-point of the reactor furnishes the means of connection to the line.

The operating mechanism used by the General Electric Co. for tap changing is shown in Fig. 5 and in Fig. 6 is shown the scheme of connections used. One side of A of the parallel circuit is opened by means of an oil switch, the position of its ratio adjuster changed and the winding again connected in circuit. The other side, B, is then opened, its ratio adjuster brought to a corresponding position and the circuit closed. One circuit must carry the entire current during the changing of adjuster setting when switch is open and a circulating current will flow between the two parts of the winding while ratio adjusters A and B are not on the same taps.

The tap changing device developed by the Packard Electric Co. is shown in Fig. 7 and the connections in Fig. 8. In this device, an ingenious selector plate prevents more than one handle being plugged in at the same time. It is necessary, however, to throw off the power when operating this tap changer.

In the Allis-Chalmers tap changer a rotating contact operating inside the transformer case is operated by means

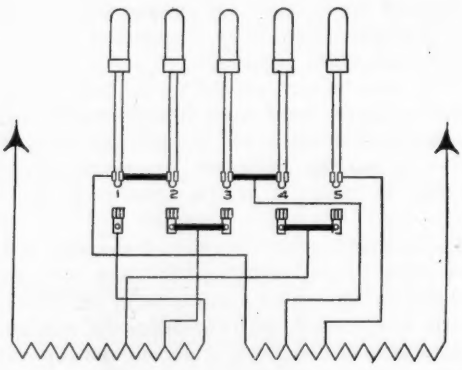


FIG. 8. CONNECTIONS FOR PACKARD TAP CHANGING DEVICE

of an insulating rod through universal joints from the outside of the case.

An arrangement somewhat similar to the latter has been developed by the Pittsburgh Transformer Co. This switch is immersed in oil and has an operating rod insulated from the switch itself extending through a stuffing box in the cover. It is operated by drawing up on the switch handle, turing it to the desired location, and then pushing down to close the switch inside of the transformer.

Two-Stage Superheating in St. Paul Plant

IN THE May 15 issue of Power Plant Engineering on page 529 is shown the cross section of a boiler and furnace. In the caption it is stated that this shows the location of a radiant heat superheater in the bridgewall in the Lakeside Power Station. This cut was used in error. It does show a radiant heat superheater in the bridgewall but this installation is in the plant of the St. Paul Gas Light Co. at St. Paul, Minn.

Three of these boilers were built for this company by the Heine Boiler Co. They are designed for 325 lb. pressure and have a normal rating of 1044 hp. each. Superheating is accomplished in two stages by Foster superheaters, the final amount of superheat being 235 deg.

Another feature of these boilers is the water screen which is connected to the boiler through six tubes of the bottom row of tubes. The water going through the screen leaves the boiler through these six tubes, makes the circuit of the screen and returns as steam and water. This steam and water re-enters the path of circulation in the boiler through the bottom row of tubes. The box header type of boiler is the only one in which this type of screen connection can be made.

Interconnection Proposed for New England

DEVELOPMENT OF WATER POWER SITES IN NEW ENGLAND AND QUEBEC WITH ADEQUATE INTERCONNECTION WOULD BE OF BENEFIT TO BOTH SECTIONS

EARLY DEVELOPMENT by New England and Quebec jointly of some of the water power sites on the tributaries, followed by development of larger sites on the St. Lawrence River as soon as the international canalization of the river is completed, would work to the mutual advantage of Quebec and New England, according to an exhaustive survey of hydroelectric power development possibilities just completed under the direction of the Associated Industries of Massachusetts.

While the survey was made by the Massachusetts association, the report itself is of a broad scope and includes besides Massachusetts, New Hampshire and Rhode Island.

This survey was made by a special commission of the Associated Industries and over a year has been spent in study, surveys and travel to the sources of probable power sites. The result is a report in which the matter is not only broadly treated, but in which the investigators have gone into details to considerable length securing material which may prove of great value in proposals for rearrangement of existing state laws and international treaties for the benefit of all parties concerned.

On Mar. 21, 1923, selection was made of the following commission to have charge of the survey: Charles T. Main, consulting engineer, Boston, chairman; George L. Finch, power superintendent of the Hood Rubber Co., Watertown, Mass., secretary; Henry I. Harriman, president of the New England Power Co.; Dugald C. Jackson, engineer and instructor at Massachusetts Institute of Technology, and B. Preston Clark, vice president of the Plymouth Cordage Co., Plymouth and Boston, Mass. The commission had the assistance and cooperation of practically every power company in New England and Canada.

NEW ENGLAND POWER REQUIREMENTS

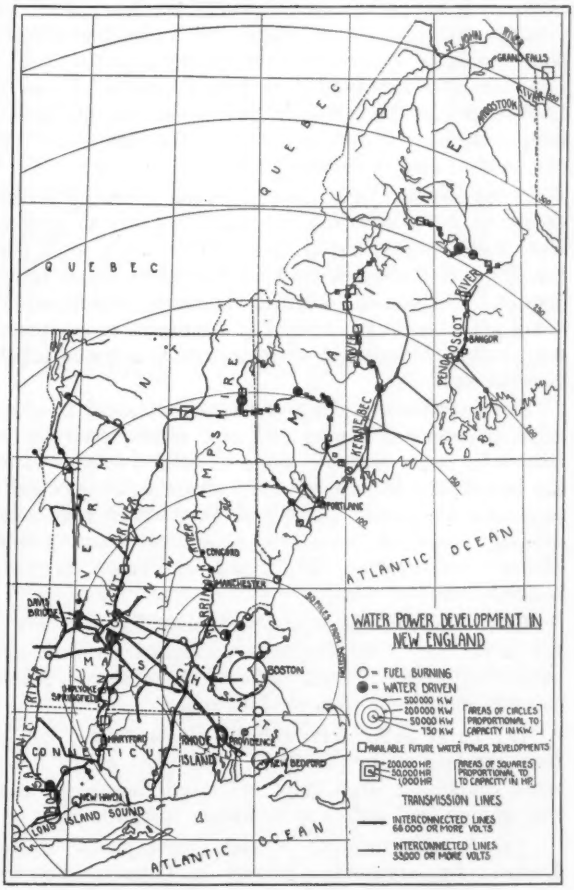
In 1922 the industries of Massachusetts required for their load of about 1,250,000 hp. a total installed capacity of about 1,800,000 hp. Of this amount about 300,000 hp. consisted of steam generating capacity in industries which required considerable amounts of steam for process work as well as power. The total energy used in New England in 1922 (except in steam locomotives) was about 7,500,000,000 kw.-hr., of which about one-half was generated by the industries themselves and the other half by the public utilities. Of this amount, about 2,200,000,000 kw.-hr. was generated by water power.

The power systems of Massachusetts, New Hampshire and Rhode Island are already interconnected in such a manner as to make it advisable to treat the power required for this area as a group centering around Eastern Massachusetts, rather than to consider Massachusetts alone.

In 1922 the energy used in this district was about 4,900,000,000 kw.-hr., of which the public utilities produced about one-half. Of the total about 1,000,000,000 kw.-hr. was produced by water power and the remainder from fuel.

Judging from the past the indications are that the total power requirements for New England 10 yr. hence will be at least 15 per cent and possibly 20 per cent more than they are now and that the same relative increase will hold for Massachusetts alone.

The rate of increase of the load on the central stations is greater than that of the total power demand, and it is expected that on an average for the next 10 yr. the load on the public utilities will increase each year by the following amounts, which may be regarded as conservative estimates: For the Massachusetts-New Hampshire-Rhode Island group centering around Eastern Massachusetts, 90,000 kw. net additional capacity will be required and 190,000,000 kw.-hr. per year will be generated; for all New England 100,000 kw. and 300,000,000 kw.-hr.



PRESENT STEAM AND WATER POWER DEVELOPMENT IN NEW ENGLAND SHOWING POSSIBLE FUTURE HYDRAULIC DEVELOPMENT

This would mean that during the next 10 yr. approximately 1,400,000 kw. of central station capacity must be added to that already existing in New England, in addition to the necessary replacements.

To electrify the additional railroad trackage on which electrification would be desirable in the near future, would require about another 1,000,000 kw. of station capacity and 2,000,000,000 kw.-hr. a year after the electrification is accomplished. Such electrification of the railroads will, of course, depend upon their financial condition.

The question now being considered, is where can the necessary increase in power be obtained at reasonable costs.

Hydraulic Development in New England and Quebec Could Meet Future Demands

There is undeveloped water power in New England at sites where 1000 hp. or more is available for 60 per cent of the time, about 860,000 hp. or 640,000 kw. If it could all be fully developed for a 50 per cent load factor, this would require a station capacity of 1,720,000 hp. or 1,280,000 kw., and would produce about 4,830,000,000 kw.-hr.

This would be sufficient to take care of the requirements for several years not considering the electrification of railroads but unfortunately about three-quarters of this undeveloped power is in Maine and under the existing laws, cannot be exported. There remains in the rest of New England about 150,000 kw., equivalent to about 1,200,000,00 kw.-hr. Most of this power will not be developed in the near future because of the high cost of the development and of delivering current.

It appears that in all New England, including Maine, enough could be developed at reasonable cost to produce about 3,000,000,000 kw.-hr., and of this only a small portion is in the Massachusetts-New Hampshire-Rhode Island district. The balance (requiring interstate transportation) is not available, in the absence of legislation or a supreme court ruling, declaring electric power to be a lawful article of commerce.

Some additional water power can be obtained from the small undeveloped powers and used either locally or as feeders for larger systems. Some additional surplus power can be supplied at Lawrence, Holyoke and Turners Falls. A greater amount of power can be obtained from some existing properties by redevelopment to obtain greater efficiency and capacity. The total from all such sources is, however, relatively small.

In view of these facts it appears that the great bulk of the power for New England's additional requirements, particularly in the district centering about Eastern Massachusetts, must come from the following:

(a) Large public service steam plants, located not far from the load centers so as to obtain coal at the lowest rates, containing large units and interconnected so as to run on high load factors at minimum operating cost; or

(b) A supplementing of such steam plants in New England by large water powers in Canada, if proper arrangements can be made for the export of electric current.

There are two such potential sources of such water power, the large developments on the tributaries of the St. Lawrence in Quebec, in the early construction of which private capital is already engaged and which can be economically developed in progressive steps, and the still larger developments on the St. Lawrence which undoubtedly must wait for the international canalization of the river.

Broadly considered, the development of water powers as fast as the load is created to absorb the output is highly desirable as a measure of conservation of irreplaceable fuel resources. Nevertheless, they must be justified economically before they can attract the necessary capital.

Taking a broad view of the demands that will be made in the near future upon every available resource for transportation and power, it is merely a question of time before the St. Lawrence canal will be constructed. It is possible that permanent power from this source may be available for New England by 1935 or 1940.

In the meantime, it is to the mutual advantage of both New England and Quebec to promote for their joint use the early development of some of the water powers on the tributaries of the St. Lawrence. The crowded industrial centers in southern New England need this water power which now runs to waste and the domestic plants and paper industries of Quebec look to this side of the border for their essential coal, the cost and difficulty of securing which is continually increasing.

Inference should not be drawn from comparisons of cost that have been made in the report that it is possible for water power to free the industries from their dependence upon a supply of coal; it can merely prevent the cost of power from mounting continually to higher levels, and it can lessen the hazard due to interruption of the coal supply. If such water power were to be imported in competition with (instead of supplementary to) any and all steam power, its load factor would be reduced and its cost increased.

Hourly load factors of industries are so variable that, even when tied together in large power systems, the annual peak load is perhaps two and a half times the average load. Water power from a distant source will best serve New England by being transmitted at as uniform a rate as possible, that is, on a high load factor and delivering as much surplus power as can be absorbed by the shutting down of steam driven units while water is wasting over the dams. Hence such imported water power will be used to supplement the steam power and one of the principal uses of the nearby steam plants will be to take the load peaks in regular and stand-by service. Few steam driven units will have to be run at night with these large supplementary water powers available. The steam load factor or hours of operation is bound to be less and the water load factor more than for the average power demand.

Both the size and character of New England's load requirements will continue to demand fuel for a large part of the load. It is to be expected that the interconnection of large water power and steam plants will result in dismantling only the smaller and less efficient steam plants.

The railroads form an important class of power users, and with the electrification of their busier lines, which seems to be the logical and probable development of the future, they will become large consumers of electrical energy.

Possibilities of Development on the St. Lawrence and Its Tributaries

Water powers of Canada which are of interest to New England as possible sources of additional power are those on the St. Lawrence River, and on the principal rivers in the Province of Quebec. The total water power on these rivers is estimated to be about 15,000,000 continuous horsepower, about 10,000,000 of which is within 500 mi. of Boston.

Investigations of the engineering features of transmitting the nearer blocks of Quebec water power to Massachusetts show that it is entirely possible to transmit this power without incurring excessive losses and with sufficient reliability and stability.

There are three important water-power sites on the St. Lawrence River. These are located between Ogdensburg, N. Y., and Montreal, all within about 250 mi. from central Massachusetts. Preliminary studies of these power sites have been made at various times and it is reasonably

definite that from the physical standpoint, no great difficulties need be expected in their development. The amount of energy which could be delivered from these plants to distant points is from 20,000,000,000 to 25,000,000,000, kw.-hr. yearly, depending somewhat upon the manner of the development.

Development of the first of these powers would probably require from 6 to 8 yr. after the Canadian and United States Governments would agree upon a plan of procedure and the financing of the undertaking, for any part of the river forming the international boundary, or for that part wholly in Canada. It is evident that even if favorable governmental action were actively begun at once, no power could be hoped for from the St. Lawrence River in less than 10 yr.

Besides the St. Lawrence River, the principal rivers in the Province of Quebec, which may be considered as sources of water power for New England, are the Ottawa, St. Maurice, Saguenay and St. Francis.

The total available continuous power on these rivers is about 5,000,000 hp., of which about 700,000 is now developed, and about 600,000 is under construction.

Large storage reservoirs have been developed on the Ottawa and St. Maurice rivers, which have a considerable equalizing effect on their flow. The Saguenay River is now under development, both as to storage and power, at the outlet of Lake St. John. The ultimate development at this point will produce about 1,000,000 hp. continuously.

The 16 principal undeveloped water-power sites on the Ottawa, St. Maurice and Saguenay rivers, which will be affected by the storage development on the headwaters of these rivers, have an estimated possible continuous output of about 2,500,000 hp. This includes one site on each of these three rivers which is now under development. All of this 2,500,000 hp. of continuous power lies within a radius of about 450 mi. from the approximate center of the power demand in New England, that is, eastern Massachusetts.

This 2,500,000 hp. of continuous power is equivalent to about 12,000,000,000 to 15,000,000,000 kw.-hr. of delivered energy and would call for an installation of about 5,000,000 hp. of power equipment, on a basis of 50 per cent load factor. About 600,000 hp. of continuous power, or about 3,000,000,000 kw.-hr. of this undeveloped power lies within a radius of 300 mi. from eastern Massachusetts.

Detailed studies and estimates of cost for the development of most of these power sites have been made, and they indicate that the power could be produced at the power house for an average cost of about 0.35 cent per kw.-hr. generated, if the plants are equipped with machinery to handle the output on a 50 per cent load factor basis.

Considering the distances over which this power would have to be transmitted (from 275 to 425 mi.), and the cost of transmission lines, it would not be economical to attempt to bring any of this power into Massachusetts, except in quantities approximating 1,000,000,000 kw.-hr. per year within a year or two after such lines are completed. It is essential that a sufficient market be developed to utilize fully the output of one or more of the plants. The cost of the necessary transmission lines and other auxiliary equipment for a 1,000,000,000 kw.-hr. project on a 50 per cent load factor basis, together with the loss of power in transmission and delivery to customers, would make the cost of power, delivered to users of large quantities in eastern Massachusetts, probably not over 1¼ cents per kw.-hr.

This is the average cost on a load factor of about 50 per cent. It does not include any allowance for the increased operating cost of the steam portion of an interconnected system whose load factor is less than 50 per cent.

These figures do not allow much for developing the business, but assume that practically all of the initial 1,000,000,000 kw.-hr. can be marketed in about two years after the completion of the undertaking. Such a tremendous amount of power might not be marketed completely in such a short time, with the result that the excess carrying charges during the period of incomplete use would increase the cost.

Assuming that it is desirable, from an economic standpoint, on the part of both New England and Canada to bring a substantial amount of hydroelectric power from Quebec to New England points, it would seem a better plan to make a beginning with power derived from the smaller power sites of the Ottawa, St. Maurice and Saguenay rivers, rather than from the St. Lawrence power sites, since, because of the reduced carrying charges, the initial cost of supplying the demand for some time to come would be much less with the smaller plants.

Locating Grounds on Motor Circuits

By A. Haist

ONE of the most common sources of trouble in the operation and maintenance of electric motors is the accidental grounding of the windings. In many cases, the trouble is difficult to locate.

Alternating current systems will as a rule give a potential between any one phase and the ground, approximately one-half of the line voltage between phases. If one phase becomes grounded the difference in potential between that leg and the ground is zero while the voltage between any of the other legs of the system and the ground will be the same as the voltage between any two phases. If, for instance, a voltmeter is attached to a grounded conductor and the ground there will be no indication but if it is connected to one of the other phases and the ground, it will register full line voltage. A ground on one phase of a three-phase system will often cause the insulation on a motor to break down.

A motor connected on a 440 v. three-phase system that is not grounded may operate perfectly, but if it is moved to a new location and connected to a system which has one leg grounded at some point, the motor may give trouble or its life may be seriously shortened.

It often happens in winding a motor that the slot insulation becomes cracked or is damaged in some other way just at the point where the coil leaves the slot. Such a machine might test O. K. on the factory test but when placed in service, vibration, centrifugal action, etc., may cause the damage to become more serious and finally provide a path for the passage of current.

Now if this motor were connected to a system with no other dead grounds or ground leaks no damage would be done as far as the motor is concerned, or if there is a ground on the same leg of the system at some other point there will be no effect. If one of the other phases should happen to be grounded, the grounded coil in one motor will have to withstand the full strain unless it is grounded solid enough to blow the other ground. The chances are,

however, that several fuses would be blown before this would occur.

In the writer's experience, one of the best methods for locating grounds on any of various motors on a three-phase system is by means of a radial switch having a contact point for each phase and a voltmeter. One side of the meter is connected to the arm of the switch while the other side is connected to a good ground. The accompanying diagram shows the connections. This arrangement enables the operator to check up on all phases at any time.

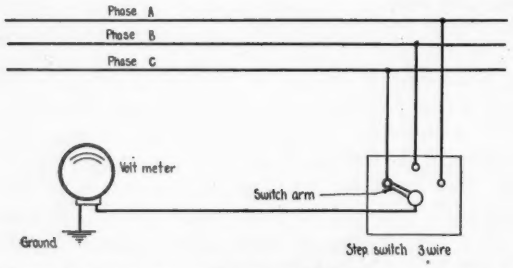


DIAGRAM SHOWING USE OF VOLTMETER AS A GROUND DETECTOR ON A 3-PHASE SYSTEM

This method, in the author's estimation, is far better than methods using lights for a ground test because you have the exact readings before you. A ground might exist but not strong enough to detect by lamps while with a meter the slightest deflection will be noticed.

It is obvious from the foregoing that if a conductor is grounded the potential difference from the other legs to ground is the same as the line voltage. Now, then, if a worker should become grounded while working on a faulty system or by using faulty equipment, and by chance come in contact with the line, if he happened to touch the grounded leg it would not hurt him, but if he comes in contact with any of the other phases with this first one grounded at the same time, he will receive the same voltage as if he were directly across the line, which many times proves fatal, while if he were to come in contact with the line and ground on a perfectly good system he would not be nearly so likely to be injured. So for safety's sake be sure that there are no grounds on your system and if there are lose no time in clearing them up.

Now, as for the operation of our ground detector, mount it some place where it can be operated conveniently. When a ground is noticed, station one man at the meter and start a man through the plant, shutting machines down. All that is necessary is just to throw the switch off, wait a moment and then throw it on again. When the defective circuit is found, the observer will notice a change in the meter reading.

Grounds are more likely to occur on the motor side of the switches. It is to be recommended, therefore, that the various motors be stopped individually.

Progress in High Pressure Piping Details

RECENT TESTS SHOW EFFECTS OF EXPANSION STRESSES IN PIPE. PROGRESS BEING MADE IN FLANGE BOLT MATERIALS AND DESIGN

TREND of the work of standardizing steam piping, valves and fittings is indicated in a recent report of the prime movers committee of the N. E. L. A. This report shows that standardization is being attempted for steam temperatures of 750 deg. F. at operating gage pressures of 250, 400, 600, 900, 1350, 2000 and 3200 lb. per sq. in. The 250 and 400 lb. steam standards will be based on the American Standard 250 lb. cast iron drilling and bolt circle with modifications in thicknesses and face to face dimensions for the 400 lb. standard. The 600 lb. steam standard will be based on the 800 lb. hydraulic standard, modified and the 900 lb. on the 1200 lb. hydraulic standard modified.

Pipe Bends and Expansion Joints

Since presenting their paper on "The Elasticity of Pipe Bends" before the A. S. M. E., Messrs. Crocker and Sanford have extended their investigation to cover the characteristics of pipe lines as actually installed in a power plant. Tests made for both hot and cold conditions on a long 10-in. superheated steam line anchored at its ends and containing several 90-deg. turns seem to indicate that under such conditions the force at the anchorage set up by expansion is even greater than that given by the formulas in their paper. These formulas were for ideal conditions with the bend anchored at one end only and free at its other end. It should also be noted that the allowable expansion as given by their formulas is less than that given in the previously published tables in common use. Consequently it would appear that the figures obtained from the solution of their formulas are closer to the conditions found in actual power plant pipe lines than are the figures given in the tables generally used. More tests are to be made from time to time as steam lines in the power plants are available for that purpose.

Tests of Bolts

On several occasions steamfitters have broken bolts when attempting to turn the nuts. Sometimes this occurred when nuts were being turned with a wrench and other times when nuts were being hammered so as to loosen them. Reports regarding these cases come from plants where high pressure superheated steam is being used. A number of different sizes of bolts from service in such plants was obtained in order to test them.

While the bolts were not all of the same manufacturer's make, they were all of the ordinary square-head bolt type made of mild steel such as is commonly used for bolts. The results obtained indicated that all bolts are not affected in the same manner under the same conditions. It was found that a great many of the bolts were brittle with low elongation and tensile strength, which shows that ordinary bolts are not suitable for high pressure superheated steam work.

In making the tests, the question of brittleness was in mind. The tests were made by pulling the full size bolts in a tensile testing machine and in order to have a condition about the same as a steamfitter has when he starts to turn a nut on a bolt which is in service, the nut was hit with a hammer (about 1 lb. weight) at each increment of 5000 lb. pull. In every case where the results show low elongation, the nuts snapped off when struck a light blow.

Proper Time to Heat Treat

Another phase of the bolt question is whether a stud should be heat treated before or after it has been threaded, the idea being that it would possibly be easier to cut the thread on the stock as it comes from the mill before heat treating. While this may be an advantage there are even greater disadvantages caused by heat treating after the threads have been cut, due to the fact that material will scale during the heat treatment. This scale makes it hard to pull up properly on the nut, as it causes the metals to tear, destroying the nut and the stud. Furthermore, the heat treatment causes a certain amount of warping and change of size, all of which would affect the proper fit between the nut and the stud, as the original fit based on gaging before the heat treatment would be lost.

Design of Stud Bolt

The question of design of studs has been investigated in order to determine whether or not some special design might show advantages over the ordinary stud. The designs considered in the investigations were as follows:

1. Ordinary stud.
2. Stud threaded entire length (running thread).
3. Stud turned slightly below root of threads between the nuts.

Strains on studs are due first to pulling up to make a tight joint when the job is erected. The next strain is due to expansion of the flanges caused by increase in temperature; the extent of strain caused by expansion, however, is problematical and depends on the rate of heating, exposure and insulation.

It is possible that if the temperature of the pipe and flange is 700 deg. F., the temperature of the stud might be 400 deg. F. Under this condition, the maximum strain on the stud due to heat expansion of flange would be that caused by the difference between the flange temperature and the stud temperature which would be about 0.02007 in.

It is believed that the ordinary type of stud is good enough and that the theory which claims that the few threads just underneath the nuts take the whole strain and will "set" under relatively low loads is not correct. In reality, a stud which is threaded the full length, can be stretched more than either of the other studs without taking a "set" or, in other words, it will take less "set" than either of the other designs when stretched the same amount.

All the tests were made with heat-treated chrome-nickel alloy steel studs. A great deal of this material has been in service under high temperature conditions and records do not show that studs of this kind made of the ordinary design have ever failed.

Advantages of Case Hardened Nuts

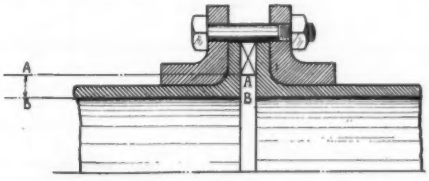
Ordinary cold-pressed, semi-finished steel nuts can be improved considerably by casehardening. The hardening has three advantages, which are as follows: First. The flanks of the threads are not so likely to tear when pulled up tight on the stud threads as they are when an ordinary nut is pulled up on the stud. Second. The nut will hold its shape better, especially the sharp corners, when a heavy pull is applied with the wrench. Third. The hard surface does not cause so much friction at the point where the nut bears against the flange.

Casehardening is an advantage and an improvement over the ordinary nut in all cases but especially so in cases where the joint is broken frequently. Some doubt exists as to how the casehardening would stand up under temperature but this doubt was removed after checking some casehardened nuts which were in actual service under 800 deg. F. for approximately 20 days of each month during a period of one year. There was no indication that the casehardening had been destroyed. In this particular case the joint was taken apart approximately every third day. The size of the stud and nut was 1½ in. in diameter. The flange joint in which the studs and nuts were used was thoroughly insulated with a heavy covering so that nuts were subjected to as high a temperature as could be obtained by having 800 deg. inside the pipe.

Incorrect Gasket Size

By W. F. Schaphorst

MANUFACTURERS of square lapped Van Stone joints go to considerable trouble and expense making square laps. It is much easier to make the corner rounded as was first done years ago. Manufacturers of gaskets are aware of this yet the writer knows of instances where these manufacturers instruct users to place them as indicated in the sketch. This is wrong because it leaves the gap AB.



THIS GASKET OF INCORRECT SIZE WILL CAUSE EDDIES IN THE STREAM OF STEAM

This gap should be entirely filled. By leaving gap AB, the purpose of the square lapped joint is defeated. Eddy currents will be established and the friction of the pipe of course will be increased.

Either the width of the gasket should be great enough to fill the entire space from the bolt to the inner edge of the pipe, or it should be of the same or some intermediate width with an internal diameter equal to the internal diameter of the pipe. The object in squaring the corners in the Van Stone joint is to make the interior of the pipe so smooth that fluid friction is not increased by the joint. Any roughness or irregularity at the joints is bound to cause additional friction.

When Is an Inch Not an Inch?

To most of us the inch is a definite and well defined thing and when we say an inch we mean an inch, within certain tolerance limits, to be sure, but the standard does not vary.

Not so with the lumber industry. The question was discussed at a recent meeting of United States Chamber of Commerce with Secretary Hoover, "How thick should a one-inch board be?" This is no joke, as anyone engaged in building from specifications will testify. Thirty-two different thicknesses of one-inch board are in current use.

This condition unnecessarily complicates matters and it is with a view of eliminating this complication that a single standard in this respect has been suggested.

Central Station Heating Requirements

CONSERVATION OF FUEL DUE TO DOUBLE USE OF STEAM, I. E., FOR ELECTRIC GENERATION AND COMMERCIAL HEATING PURPOSES. CENTRAL HEATING SHOULD BE A BUSINESS NOT A HOBBY. A MODERN HEATING SYSTEM AT GRAND RAPIDS. MODERN UNDERGROUND CONSTRUCTION. BY H. A. WOODWORTH

PARAMOUNT in every wide-awake utility manager's mind is the question, "How can I increase my power plant efficiency and at the same time double my revenue without increasing the quantity of coal I am burning—what is the ideal condition for this result?" Take, for instance, a power house equipped with non-condensing engines. The proper thing is to connect a central heating system to the exhaust line, utilize all the exhaust steam and the plant revenue will increase 100 per cent as compared with operating condensing.

BLEEDER TYPE TURBINES TO BE USED

When a new power plant is to be built for electric power and the exhaust steam is to be used for central station heating in winter and process work, i.e., cooking, hot water heating, etc., in summer, the bleeder type turbine is the best unit to install, as you can bleed just the amount of

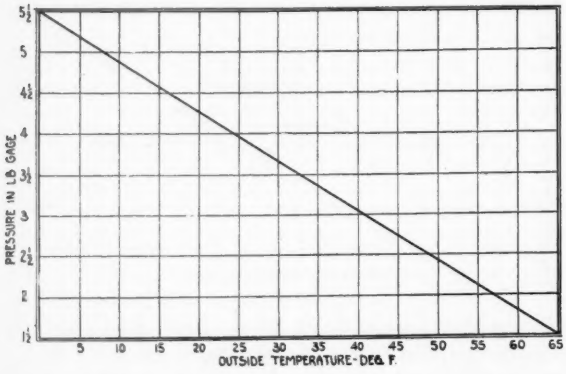


FIG. 1. PRESSURE IN HEATING MAINS SHOULD BE RELATED TO OUTSIDE TEMPERATURE AS SHOWN ON THIS CHART

steam you require at any season of the year. The bleeder turbine is a form of condensing turbine from which steam may be drawn for heating purposes. It is recommended in plants where the demand for exhaust steam would make a non-condensing machine uneconomical. Mixed pressure turbines should be designed with reference to conditions under which they are to operate. With the bleeder type turbine 100 per cent of all exhaust steam can be sold and the efficiency of the plant greatly increased.

CENTRAL POWER AND HEATING ECONOMICAL

From the customers' standpoint they realize that their new buildings are primarily a new business enterprise, designed to earn a reasonable return on the capital invested and, if a reduced expenditure for machinery and a lower cost of operation can be assured in advance, some of the difficulties which discourage the investment of money in building operations, especially during periods of high construction costs, will be removed. One of the most important economies in building operation is the general adoption of purchased electric power and electrically operated machinery in conjunction with the use of low pressure steam. In the economical new building of to-day, electrically operated machinery is used almost exclusively; such appliances cost less to install, occupy far less floor space and require less attention and expense to operate. The heating of buildings and operation of hot water apparatus are, however, *unsolved* insofar as the substitution of electricity for steam is concerned and must be effected by *steam*. It is generally found that power plant machinery designed to operate in this manner can be installed for about one-third the cost of other systems and is from 17 to 30 per cent less expensive to operate.

To accomplish this, the customer must be able to purchase central station steam heating. New York, Boston, Pittsburgh, Philadelphia, Detroit, Cleveland, Chicago, Indianapolis, St. Louis, Kansas City, Denver, Seattle, Salt Lake City and San Francisco and about 500 smaller cities and municipalities have central heating plants which make it possible to furnish the entire electric and heating business of the largest hotels, office buildings and industries from the Utilities' electric and heating plants at less cost than the buildings can furnish their own light and heat. Another fact worthy of notice is that a number of real estate boards, property owners and similar bodies and associations have realized the saving incident to connecting up various small plants and thus pooling the load, co-ordinating service and eliminating wastes. Where such bodies find profit, surely a central station would find profit too and should find greater profit.

It can be easily substantiated that small buildings as well as large buildings cannot afford to make their own light and heat. The practice of purchasing outside power and heat has proved, over a long period of time, to be more economical than the operation of an isolated plant. The older isolated plant never knew how much exhaust steam was actually used and how much was wasted. The central heating plant meters all steam sold, hence, it can ascertain the steam made and sold for any month, week or day of the year.

CENTRAL HEATING CAN BE PROFITABLE

District heating should be a business—not a "hobby." It is the solution of special problems—not a panacea for all power station difficulties. For district heating to pay, it must first of all be feasible. It must, secondly, be scientifically carried on, which means that proper construction and operating methods must be adopted and adhered to and equitable, adequate rates for service must be charged. In the past too many, sometimes all of these requirements for success were lacking and failure inevitably resulted. This article will attempt to treat the subject of supplying heat in a new way. It will attempt to point out existing conditions and place an entirely new complexion upon district heating.

The central station fraternity have rather forgotten that there is a need in the world for heat as well as electricity. Only by supplying both can we make fuel conservation an accomplished fact; and only by so doing shall we be able to come up to the responsibility that is ours.

The loss of heat in the conversion from chemical to electrical energy, that is, the largest single loss in the cycle of changing from thermal to electrical energy is the condensing of steam in order to obtain a vacuum on the eleo

trical prime mover. It represents a loss of 57 to 62 per cent of the steam.

The greatest opportunity for fuel saving that exists today is to co-ordinate the manufacture of kilowatt hours with supplying steam service. The two processes go together. Central stations have been so engrossed in producing kilowatt-hours that they have overlooked the fact that they are also producing heat for which a small demand exists in summer but which is all eagerly demanded in winter. Recognizing this, many modern central heating plants are being considered throughout this country and several large stations are under construction. The most interesting of these is described as follows:

Modern Plant for Grand Rapids

Construction work has been started on a new steam heating plant for the downtown district of the City of Grand Rapids, Michigan. The plant has been designed strictly for central heating at the highest feasible efficiency. It will replace the old Fulton St. plant originally put into operation about 1886 and formerly the property of the Grand Rapids Edison Co.

The purpose of the new plant to be built on the site of the old one is to supply steam for heating, cooking and laundry use in the business district and the plant is being designed to secure the greatest economy consistent with reliable heating service. Electricity will be generated as a by-product. The new plant will supply the territory on the east side of the Grand River within a radius of approximately one-half mile from the plant of the corners of Fulton St. and Ottawa Ave. The old underground steam main system is being rebuilt and extended to provide an outlet for the output. Steam will be available for distribution at 2 to 8, 50 and 100 lb. pressure.

Plant capacity will supply steam to from 600,000 to 1,000,000 sq. ft. of equivalent required direct-radiation surface and electricity of 4500 kw. at 80 per cent power factor. The current will be 30-cycle, 7500-v., a.c. 3-phase. Four boilers built for 350 lb. pressure and each having 5930 sq. ft. of heating surface will be installed over under feed stokers. The boiler units will be capable of generating steam at the rate of 100,000 lb. per hr. each.

A track hopper of steel and reinforced concrete will be provided under the Pere Marquette R. R. siding to receive coal, which will be moved into the boiler house by a belt conveyor fed by reciprocating feeder and carried over a Merrick Weightometer before discharging into the bottom run of a pivoted bucket conveyor. This conveyor will run under and over the boiler room, up one end and down the other, elevating and distributing coal over the bunkers in the top of the boiler house.

Two non-condensing steam turbo-generators will ultimately be installed, a 1500-kw. machine this year and probably a 3000-kw. unit later when the growth of the business justifies it. These turbines will be piped to exhaust either to the heating mains or to the atmosphere. It would be possible to operate these turbines exhausting to atmosphere with high-grade coal so as to average less than 2½ lb. of the coal per kilowatt-hour of net plant output, with all station auxiliary consumption of steam and electric current and all station wastes and losses taken into account. The turbines will have, in addition to the usual speed and emergency overspeed governors, special automatic governors to control the steam flow to the turbines so as to maintain the desired back pressure on the low-pressure heating mains and hand-controlled gridiron valves in the turbines will regulate the pressure on the high-pressure extraction nozzle.

With the first turbine, the following underground mains will distribute steam going out of the plant:

One 22-in. main for steam varying from 2 to 8 lb. pressure, according to the weather.

One 4-in. main for steam at either 50 or 100 lb. pressure.

One 3-in. main for steam at either 50 or 100 lb. pressure.

All steam will be desuperheated and excess moisture separated before it is discharged into the mains.

This year the following sizes and lengths of underground heating mains will be available: 1420 ft. of 22-in. main; 510 ft. of 20-in. main; 530 ft. of 16-in. main; 490 ft. of 14-in. main; 960 ft. of 12-in. main; 1400 ft. of 10-in. main; 640 ft. of 6-in. main; 3100 ft. of 4-in. main.

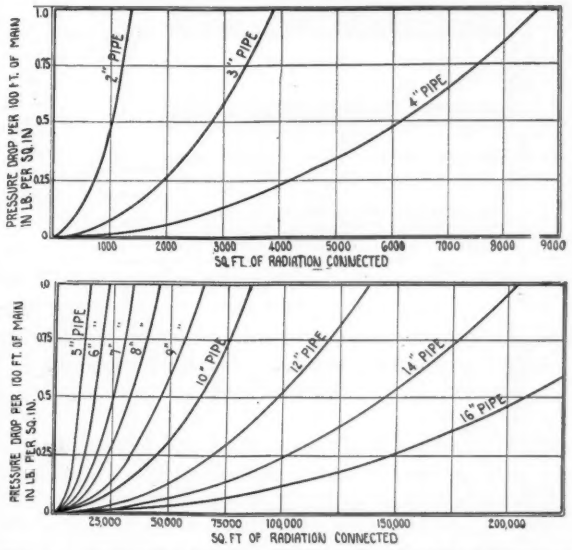


FIG. 2. PRESSURE DROP DEPENDS ON RADIATION SUPPLIED AND SIZE OF PIPE USED

This is just one of many instances of central heating expansion programs that are under way at the present time to take care of the ever-increasing steam heating service demand.

These Points Are Vital

In designing an exhaust-steam district heating plant the following points of fundamental interest must be kept in view:

First. There must be a ready market for the steam.

Second. The steam must be sold within the economic limits, so that the price may compare favorably with the cost of operating private plants on the consumers' premises.

Third. The manager must have complete knowledge of the business.

Fourth. The equipment must be arranged with a view to flexibility in the matter of service.

Fifth. The steam must be sold on a meter basis.

Sixth. The system should be planned with consideration for the demands of a future expansion of the service.

Next requiring attention is the selection of a site for the plant. The points that loom up conspicuously in the settlement of this question are these:

First. Contact with the steam heating and electric business; second, coal and freight rates; third, water supply; fourth, room for expansion of the business; fifth, switching facilities; sixth, facility for meeting special conditions.

In the design of the main station, the conventional procedure for plants is carried out. In the design of the outlying system, however, many engineering considerations of special character are involved. The prospective territory is carefully gone over and a district reasonably near to the heating plant is selected in order to reach the greatest amount of business at the least expenditure. This

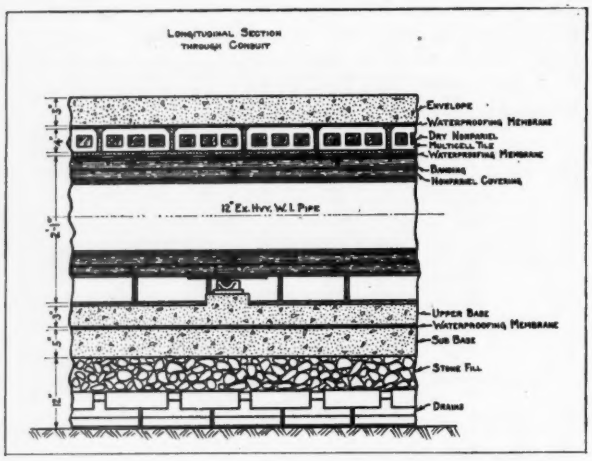


FIG. 3. LONGITUDINAL SECTION OF STEAM MAIN WITH MULTI-CELL TILE AND PROVISION FOR INSULATION AND DRAINAGE

should embrace a territory of about 1½ mi. radius from the plant, or less, depending on local conditions. A check of this territory is carefully made; the entire available business in each block is laid off on a map and the required pipe sizes determined to care for the present and future business. Proper allowance is made for extensions of the mains in any direction.

Maximum allowable back pressure is usually reckoned as 6 lb. The pressure varies according to the outdoor temperature, see Fig. 1. The transmission loss in pressure depends upon both diameter and length of the pipe. A short lateral line near the plant may have an allowable drop in steam pressure of ¼ lb. gage per 100 ft. of main, while a line at the remote points on the system is so designed that the drop in pressure will not exceed ¼ lb. per 800 to 1200 ft. of main. The distant legs on the system are so designed that the terminal pressures in all are as near the same as is possible. This gives the whole system symmetry and balance and insures minimum back pressure at the station. If these fundamentals are given engineering consideration, the flexibility of the system and size of the mains will be sufficient to take care of the inevitable growth of the plant, without the drawback of excessive back pressure or impaired service. Use Fig. 2 to determine the size of the mains.

Proper Construction of Mains

Equal in importance to careful design is the construction of the underground heating system. This must be installed by engineers specially trained in the work, using the most efficient materials that modern practice has produced. The points of most importance are insulation, a good system of underdrainage, free travel of the mains, and perfect drainage of the piping. A good inspector should be on the job to see that the company receives the best materials, including wrought-iron pipe and that all grades, depths of mains and connections conform to the original layout and specifications.

Ordinarily, the civil engineer of the construction outfit makes a profile of the territory to be covered and determines the preliminary grades. He then selects the most desirable path, sets his stakes and is ready to begin his final surface survey. The first step in the construction of a steam heating pipe line is to obtain accurately the grades or falls. The average depth of the trench is about 74 in. from the street surface to the bottom of the drain tile. The width of the trench depends on the particular kind of

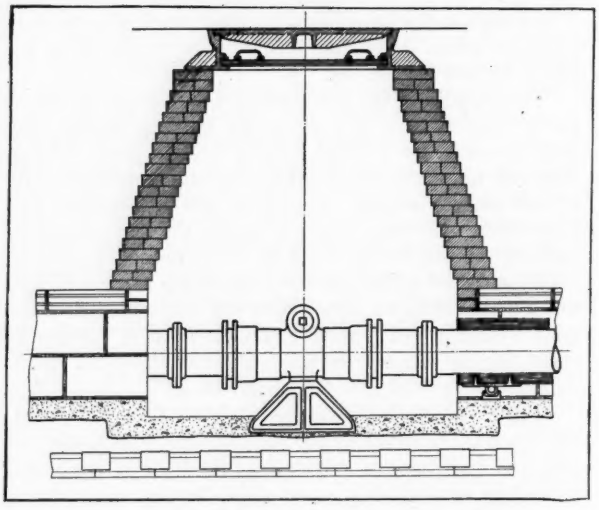


FIG. 4. VITRIFIED TILE CONDUIT PROTECTS THE LINES

construction, also upon the size of pipe to be laid. The usual practice is about the following: For a 16-in. line, a trench 38 in. wide; for a 14-in. line, a 36-in. trench; for 12-in. line, 34-in trench; for 10-in. line, 32-in. trench; for 8-in. line, 30-in. trench; for 6-in. line, 28-in. trench; 4-in. line, 26-in. trench.

Figure 3 is a longitudinal section of a steam main showing "multi-cell" tile installation and the method of under-drainage and insulation used therewith. When the proper grade of the trench bottom has been determined, the porous drain tile is laid to grade and covered with crushed stone, two and one-half parts of sand and one part of Portland cement, laid 4 in. thick. This is well rammed and finished smooth. Wherever conditions require, as in tranversing filled ground, the concrete is reinforced with steel.

After the concrete is in place and set, the pipe gang begins work. The pipe, together with proper fittings, anchors, service tees, etc., is welded. After the pipe is laid, it is tested and is made tight under working pressure.

Insulation of the pipe is the next step. Figure 3 shows the covering, which is 3 in. thick. This entire covering is made in sections 3 ft. long, each section being split longitudinally. Around the sectional insulating covering are wound two layers of 1-ply rubber roofing or its equivalent,

put on so as to break joints with the ends of the sectional covering. The laps are thoroughly sealed with roofing cement, while each section of the covering is stapled together with a sufficient number of staples to hold the longitudinal joint securely tight. All fittings are covered with a special make of plastic asbestos cement.

While the covering is being placed, the pipe line is set on blocks so as to give free access to it. After the covering is applied, the tripod lifts the covered pipe free from the blocks and cast-iron rollers, mounted on cast-iron plates or chairs which hold them in place, are placed beneath the pipe. Between the rollers and the covering is placed a shoe of cast iron, sufficiently large and of ample weight to stiffen

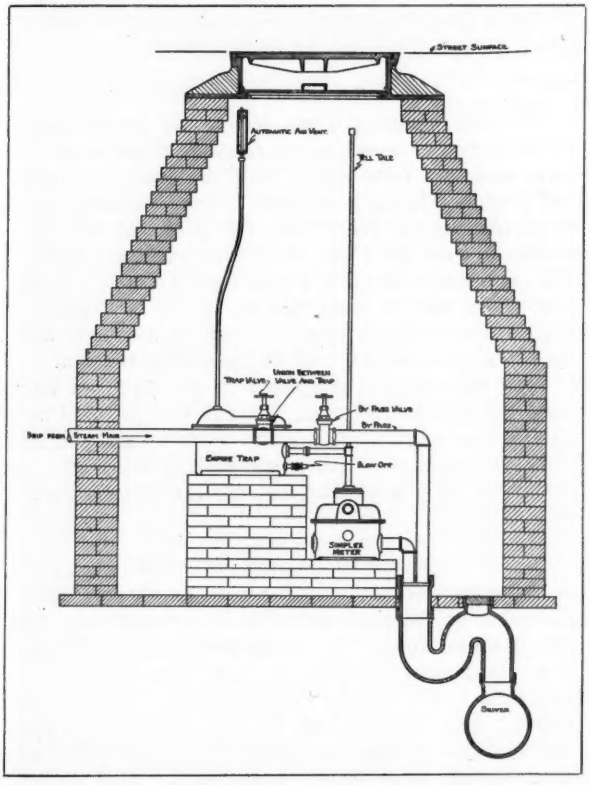


FIG. 5. STEAM TRAPS ARE USED AT THE MANHOLE TO DRAIN OFF CONDENSATION

the covering at roller points and also to ride on the rollers and assume the wear; these rollers are placed 12 ft. apart and allow the pipe line to expand or contract freely lengthwise between manholes, while holding the line in place laterally.

Next in order is the tile conduit, Fig. 4. The material used is vitrified tiling 4 in. thick and 2 in. wide, the length of each section depending upon the size of the pipe to be laid. The tile serves as a protector for the insulated pipe line, keeping it free from moisture and from contact with the soil and, at the same time, affording a sealed dead-air chamber which insures the highest efficiency. In laying the tile, a section is placed on end on each side of the pipe line, with the concrete base as a foundation. The vertical sections are filled with insulation, a good cement joint is made and then the top tile is bridged across. The cement used is a special waterproof mortar. Cement of this kind insures a perfect joint, unaffected by heat, cold or moisture and, like the tiling, it is impervious to the ravages of time. The joints are held in place by bonds during the time required by the concrete to set. Crushed stone or coarse gravel is tamped in around the partition tile, thus providing a material through which the seepage water may easily percolate to the underdrain and into the sewer connected to the bottom of the manhole.

Figure 5 shows the method of draining off the line condensation through steam traps, manhole meter and

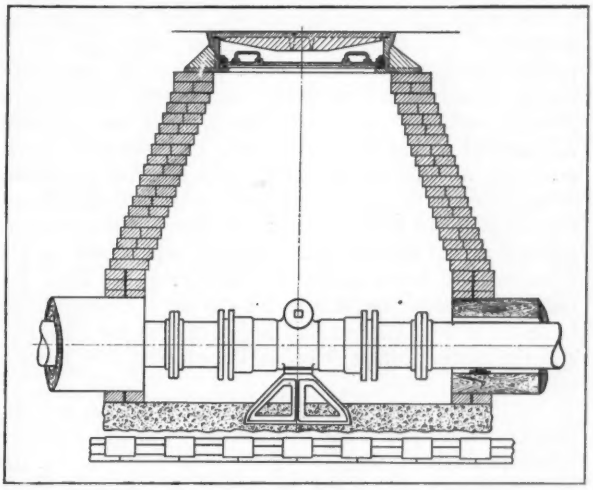


FIG. 6. FOR WOOD-CASING CONSTRUCTION, THIS MANHOLE IS USED

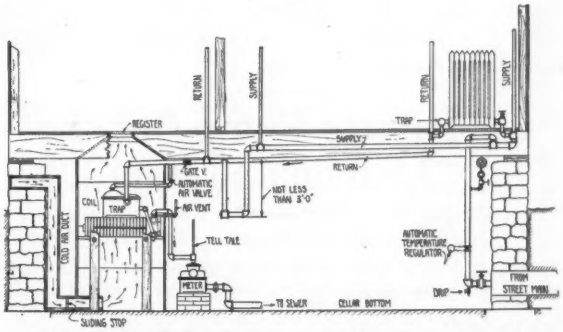


FIG. 7. CUSTOMERS PIPING FOR A 2-PIPE SYSTEM

sewer connections. Screens are interposed to protect the working parts of the traps against fouling from solid particles passing along with the condensation. By the use of these screens, satisfactory operation of the traps is practically assured throughout the heating season, while in their absence the street traps become an incessant cause of trouble and expense, on account of the accumulations of sediment interfering with their working.

The manholes, see Fig. 4 and Fig. 5, are usually 6 by 8 ft., so as to provide ample room for two men to move about in them while engaged in the work of repairing the line, expansion joints, traps or sewer. The sides are formed of two courses of brick and the top of concrete, reinforced with tee rails. The cover is made of cast iron and is double, the lower lid acting as a mud catcher as well as supplying insulation for the apparatus below. The upper lid is set flush with the pavement.

Figure 6 shows manhole with wood casing construction.

General construction work being completed, attention is turned to new business that has been signed up or may

be obtained. After the heating contract is signed, the working order is issued and the service line to the new customer is laid. The company usually charges for the cost of laying this line of pipe from the property line to the basement of the consumer but retains the right to lock the entrance valve in case the contract is violated or bills are not paid.

Inside the basement, the equipment of the building begins, see Fig. 7. This work is usually done by heating and ventilating contractors but must meet the requirements of the rigid specifications set forth by the heating company. The cost is much cheaper than that for a private steam plant for the cost of the boiler and extra piping is saved. An automatic temperature regulator, a pressure reducing valve and suitable traps are installed. All exposed piping in unused rooms or basements is covered with an efficient insulator. The required radiation, as estimated by the heating company, must be installed and the complete job must pass the inspection of the superintendent of the district steam heating department or his representative before steam will be furnished. Each job must have a sealed meter installed and the equipment must be tested to the complete satisfaction of both the consumer and the heating company before the contractor is given a letter of acceptance.

In the fall, before the heating season begins, a high-pressure steam test is made, when all traps and lines are tested to ascertain that everything is in readiness for the winter weather. With the first cold spell, the contractors are called upon to test the jobs they have equipped, clean all traps, set all air valves and prepare the system for the heating season. When the first cold snap arrives, everything is in readiness for operation without undue trouble and consequent dissatisfaction.

It Pays to Pump Out the Ammonia System

PRECAUTIONS BEFORE STARTING TO PUMP OUT. ROUTINE TO FOLLOW. CHECKING UP ON THE WORK. PUTTING THE SYSTEM BACK INTO SERVICE. BY THE MAN ON THE JOB

BEFORE attempting to pump out a direct expansion refrigerating system, be sure that you understand just how to go about it. Several matters must be given careful consideration, such as; will the condensers hold all the ammonia in the system? If not, the system will have to be pumped out in sections at the most convenient time for a shut down and when the least amount of work is being done in the plant. Next, which compressor is best adapted for the pump out job? It should be chosen so that, whether the system is pumped out in sections or as a whole, there will be the least number of valves to open and close and the connection for the suction will be as direct as possible.

PUMP OUT TO REMOVE AIR AND OIL

I believe that plants which have been in operation for 2 to 3 years should be pumped out thoroughly once or twice a year and for the following reasons: Air will get into the system, oil will accumulate and scum coatings will form. Somebody asks, how can air get in? Well, every time a compressor is pumped out to repack, a certain quantity of air gets in and a small amount will mix with the ammonia even if the system is purged. Air will seep in around the rods unless the packing is kept tight, especially on low pressure work for the atmospheric pressure is greater than the suction pressure. In connecting up new expansion coils, great care should be taken but, even then, some air will sneak into the system.

Different grades of ammonia oil will vary and some particles of oil will settle in the system. Oil traps should be placed at the lowest points in the system on each group of coils and also on the discharge line just before going to the condensers. Also there should be a trap or receiver in the engine room to take the oil from the traps on the condensers and this should be connected to a pump out line or to a low pressure suction line, which should be opened at intervals to allow the ammonia in the oil to evaporate, then the valve closed and the oil drained off.

USE FULL COMPRESSOR SPEED

To start pumping down, having the proper suction valves opened or closed as the situation demands and the main ammonia valve closed, start the compressor slowly and gradually bring it to speed. Some engineers object to pumping out at full compressor speed and say that it cannot be done but I ask, what harm can come from it? The main ammonia valve is closed and no other compressors are in use for pumping out, so you can operate at normal speed until the ammonia rods get unusually warm, then slow down and back off on the stuffing box nut.

One who has had experience in pumping out knows that during this operation, the rod will get cold after awhile, then shortly will begin to warm up and you must loosen the stuffing-box nuts or the packing will burn. The nearer you get to a vacuum, the more closely must the rods be watched.

PURGE TO RELIEVE PRESSURE

Also, the discharge pressure must be watched and not allowed to go above 210 lb. If it should reach that value, shut down for awhile; then go up to the purge valve which is at the highest point of the condensers and open it a very little until a hissing sound is heard. You will notice a bluish vapor coming from the valve, which is air escaping from the system. In about 30 sec. this will change to a whitish vapor which is ammonia. Then shut the valve and, after waiting awhile, repeat the operation, continuing this routine until no further air comes from the purge valve.

Exceptionally high head pressure will not occur where condenser capacity is sufficient to hold the entire ammonia supply, unless a great amount of air is in the system.

Going back to the engine room, you will find that the discharge pressure has dropped and you can resume pumping and continue until the suction pressure shows at 5 in. vacuum. If it will not hold at this after the compressor stops, continue the pumping until it will and meantime examine the main ammonia valve or valves to see whether they are leaking. If they are, pour the hottest water you can get on the valve and tighten up the packing nut a little. This will generally eliminate the leakage.

After you have secured a vacuum which will hold and be maintained in the system, let the plant stand awhile with the compressor shut down, as it will take some time for the air to work to the top of the condensers. It will gradually do so and you can purge at intervals until all air is out of the system.

Each engineer must make use of his judgment, for conditions will vary according to differences in plant construction but the purpose is the same in all cases.

Most plants have a pump out line of ¾ to 1-in. pipe running through the entire plant, and connected to a pump out line in the engine room so that, if anything happens to any section or coil, it can be pumped out directly, without interfering with the operation of the plant. This is an emergency operation and in no way takes the place of the regular pump out of the system.

Inspect All Parts

To make a thorough pump out should take at least half a day or more, depending on the size of the plant. After you have pumped down to the final point, make a thorough inspection of all parts of the system. Leaky valve stem packing should be replaced; old and corroded pipe and coils should be replaced or repaired; all pipes should be cleaned.

Restart Slowly

After everything is in ship shape, you are ready to start up again. Reset the suction valves for general operation. As all expansion valves are open, you should just crack the main ammonia valve and when 5 or 10 lb. shows on the suction gage, start the ammonia compressor very slowly and continue until the pressure is at or a little above normal; then gradually bring the machine up to speed. Meantime gradually open the main ammonia valve, so that it is wide open by the time that the compressor is up to speed.

Another way to start up is to leave the suction valves to the compressor closed and gradually open the ammonia valves until they are wide open and the suction pressure is normal. Then start the compressor extremely slowly, having one man at the throttle and another at the suction valves, just cracking them and opening up gradually until they are wide open. Then gradually and cautiously bring the compressor up to speed.

Reset Expansion Valves

Somebody familiar with the setting of the expansion valves should now make the entire round and reset all these valves. It will be found that a less amount of ammonia will be needed and a great improvement in the working of the system will be noticed.

When pumping down, after the system is about pumped out, the ammonia line will begin to frost over which shows that ammonia is nearly all out of the system. With continued pumping, the frost melts off the lines and the pipe becomes moist and looks sweaty, but this disappears as the system nears a vacuum.

Do not ever try to drain oil out of the system or traps without first closing the pressure valves as it is a dangerous procedure. But keep traps well cleared of oil and condensers well purged of air and it will save many dollars and much work.

To polish brass, apply a paste composed as follows: Three parts of oxalic acid are dissolved in 40 parts of hot water, to which is added 100 parts of powdered pumice stone, 2 parts of oil of turpentine, 12 parts of soft soap and 12 parts of a fat oil.

Theoretically coal requires something over 7½ lb. of air per 10,000 B.t.u. liberated.

Clean Air for Compressors

Provide plenty of light and ample room all round the compressor for cleaning and inspection. In foundries, wood working plants, etc., where there is excessive dust, locate the air compressor in the main engine room and where this is not possible, in a dust-tight room with provision made for drawing clean air from the outside to the compressor intake. This is the advice of the Compressed Air Society.

Compressor foundations should be substantially and solidly supported. The depth and cubical contents will, to a great extent, depend on local conditions of soil and the type of machine to be installed. On account of vibration, concrete walls and floors of the engine room should not be tied rigidly to the compressor foundation.

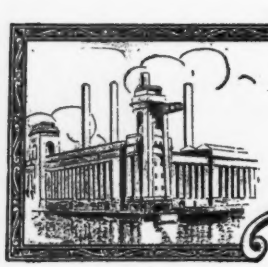
Air intake should be run outside the engine room so as to admit the air at some height above the ground level. The end should be suitably hooded and provided with a wire screen and strainer to keep out dust and dirt. The strainer screen should have at least four times the area of the suction pipe and should be so constructed as to be easily removable for cleaning, as it may become foul with rubbish to such an extent as to choke off the air supply. Piping should be the full diameter of intake opening on air cylinder with an increase of 1 in. in diameter over this size for every 8 ft. in length. An actual gain in delivery of 1 per cent is obtained for every 5 deg. F. temperature reduction of the intake air.

In many industries today it is impossible to locate a compressor intake so that clean air can be taken into the machine without some form of air cleaner or filter being connected with the intake piping.

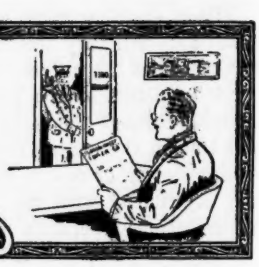
One simple form of cleaner which can be made at any plant consists of a wooden frame box made with removable panel frames covered with heavy ½-in. mesh wire to which cheese cloth or loosely woven cotton flannel is tacked. The cheese cloth takes up all the heavy particles of dust and foreign matter. When the cloth gets completely covered it should be renewed. Ample screen area should be provided, at least 1 sq. ft. of surface per 25 cu. ft. per min. free air capacity of the compressor. With this amount of surface there will be no appreciable loss of pressure in the air going to the compressor.

Another form of air cleaner which can easily be made at any plant consists of a metal tank in which several layers of washed cobble stones are set, these stones being laid on heavy wire mesh partition plates. The stones are coated with a heavy body high flash point oil; the dust in the air adheres to the oil. Such a cleaner can have the stones removed periodically and cleaned.

There are today different forms of filters which can be purchased as manufactured articles which are made to attach to the intake pipes of compressors. One which has had considerable use consists of a box with a filter shell containing short brass tubes covered with viscosine. This filter gives good results with a negligible pressure drop and requires cleaning only once every six to ten weeks, depending on the service to which it is put. Other forms of filters on the market are those which consist of a large surface of special felt, through which the air must pass, and others which have a fan operated by the rush of air through the intake pipe which operates a centrifugal device and is supposed to whirl the dirt out of the air. Any filter which will clean the air may be used.



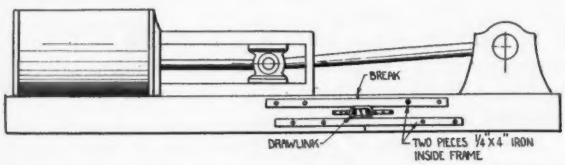
LETTERS DIRECT FROM THE PLANT



Engine Frame Repaired with Shrink Link

DURING THE course of my operating experience in an old saw mill we were confronted with a job that all but stumped us. One day the old engine, because of some side strain, caused probably by a settling of the foundation, broke one side of its frame between the guides and the main bearing. The break opened about 3/8-in. It was quite a job to bring the frame parts together with jacks against the building walls and rods through the frame. With all our efforts we lacked about 1/16-in. of getting the two halves together.

The mill boss, who was an old hand at all such troubles, saved the day. Under his direction we cut two pieces of 1/4 by 4-in. iron bar 5 ft. long and drilled two 3/4-in. holes



APPLICATION OF DRAW LINK TO REPAIR ENGINE FRAME

near both ends of each. Then we made up two heavy angle pieces and bolted them, in line and about 6-in. apart, to the frame, one on each side of the break. The blacksmith then made an open link that would just fit over the two ends of the angle with the two parts of the frame in place, together. He then heated it to a cherry red and slipped over the angle pieces. As it began to cool it contracted, of course, and in so doing exerted force enough to draw the two parts together.

When the break had completely closed up and the frame was in its original position we tightened up on the jack and the rods through the frame. Then, using the iron bars as templates, we drilled holes in the frame. Selecting only such bolts as would go in with a drive fit we bolted the bars to the frame. To finish and relieve the strain we picked out some of the old grouting and poured a new grouting after leveling up the frame by driving iron wedges between the frame and foundation.

Pahrump, Nev. CHAS. LABBE.

Getting Started

UNDER THE head "Getting Properly Started," Charles J. Mason, in the issue of May 1, states some important facts when he mentions the objects many boys have in view on taking a job. To my mind, it is one of the most difficult things today to find a young man who has finished schooling and who has much of an idea about what he wants to take up.

Mr. Mason states that other boys become apprentices in the various trades merely to get a job. This is undoubtedly true; however, it does not seem to apply as much to the power plant game as to industrial work. If we approach the average operating engineer who has had some years' experience, we shall find that he has drifted into a job in the plant after working at several other things and perhaps as a laborer. He has filled in on the fires in an emergency and later become a regular fireman or oiler where he has showed certain characteristics which attracted the chief engineer. In various ways he has worked up to a watch engineer, often making a satisfactory if not a brilliant showing.

I am familiar with a case where the man concerned was interested in steam from boyhood and wherever a smokestack loomed up, to it he went and stayed as long as he could. By the time he left school, he had a fair general knowledge of simple engines and boilers. First it had been locomotive engineering, then marine and at last stationary plants. Had there been sufficient opportunity in the small town where he grew up, he would have obtained a job in some plant there, but such chances were few, so he commenced to learn the machinist trade. Later he took a correspondence course in steam engineering. When he had one more year to serve in the shop, the works expanded enough to require a modern steam plant to be installed and he applied for a transfer to it from the shop but to no avail. A man with a Massachusetts license was given the job as engineer and the young man became acquainted with him to such an extent that he gathered considerable practical knowledge. His work was in a room directly over the engine room and he hurried to work in the morning and at noon in order to help start up the engine. All this was of benefit and from the engineer he obtained books and magazines on power plant subjects. When his 3 yr. were finished, on the advice of the engineer he went to Massachusetts to try for a license and at first he got a fireman's. From that he went through various experiences in different plants until he reached a responsible position with an industrial plant in charge of its mechanical and electrical department. I relate this example not because the man in question was especially brilliant but because he has kept to the same line ever since he commenced and his persistence won.

For some years the writer had charge of the power plant in a trade school and the instances where boys intended to follow power plant work were few. They seemed to think that the long hours that men formerly had to work would be impossible for them and those who expected to go into anything in the mechanical line seemed to have visions of being placed in authority at once or after a short term spent in getting acquainted with the work at hand. In the case of many of these boys, they rapidly acquired the good sense to see that they did not "know it

all" and many of them have risen to good position. In the steam engineering field, however, they seemed to be discouraged by the work necessary in the boiler plant and it was my opinion after several years of contact with these students, that there were not many potential engineers among them.

I heartily agree with the editorial of April 1 that there is something wrong and it is true that the proper foreman or superintendent must be willing to show the men under him everything necessary. On the other hand, the men must use their heads or the imparted knowledge will not help to any great extent. We have examples every day of men who seem to think that their heads are more for ornament than for anything else. Some men seem to be afraid that they will do more than they are paid for, yet they wonder why they don't get along.

Mr. Mason voices a great truth when he says that the man to get up must work outside of the regular hours. I cannot believe that there is a successful engineer today who has not had to do so. This is true to a greater extent in some cases than in others and the amount of the extra work is a fair gage of his success. For the man who has the push and energy to get out and dig for results there is a high place waiting but there must be no letup until the goal is attained.

East Dedham, Mass. G. H. KIMBALL.

Furnace Volumes for Burning Oils

IN REFERENCE to an article on oil burning by F. A. Rothwell in the May 15 issue, I should like to mention a practical experience of mine that goes to emphasize a few of the points the author brought out in regard to furnace volume.

Some years ago I was on an oil burning job equipped with Peabody burners and White heaters and pumps. In that arrangement, known as a mechanically atomized system, the oil is fed to the burners at about 110-lb. pressure, depending on the load, and the temperature of the oil is kept at about flash point.

At this particular time the turbine blading was in poor shape and as the clearances were excessive, it made a greater demand for steam on the boilers than the plant was designed for.

In view of this fact, it was necessary to force the boilers considerably and in trying to maintain somewhere near efficient operation of the burners we had to keep close tab on oil temperatures and pressures, and check it against the amount of steam generated.

Under these circumstances, we found that in using oil of about 21 deg. Bé. it was necessary to keep the temperature as high as possible in order to realize any efficiency. But right there we met a big obstacle in that we could not get the pressure at the burners over 115 lb. when running the temperature at from 185 to 195 deg. F. Just as sure as we did, the pressure in the furnace would become excessive and the fires would pulsate so badly that the furnace fronts gave symptoms of coming out on the floor plates. When steam was needed badly, I kept the pressure just under that point and in case they started pulsating we could relieve the pressure on the burner line by a bypass valve to the suction with which all such systems are equipped.

By lowering the temperature and sometimes even the pressure, we could make a lot more steam but we also made a smoke screen that would do credit to any destroyer.

Overspeeding the induced draft fan did little if any good but I later found, by experience with another job, that if the furnace volume had been larger our troubles would have been over with.

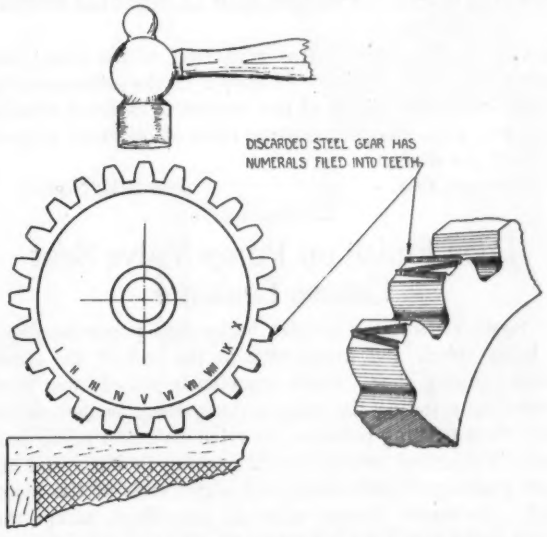
As I was on that particular job only a short time I did not have an opportunity to check the volume with relation to the heating surface and boiler horsepower but I feel certain that it was far too small and had it been larger greater efficiencies could have been attained even for normal operation of the plant. I also believe refractory expense could have been saved, for I recollect that that equipment was hard on the brick work even after the turbine was overhauled and we were running at the normal load.

At this same time we also had to change oil and the new was about 16 deg. Bé. This of course made another difference in our required oil temperature, and if I remember correctly we could then hold it around 210 deg. F. without much danger of pulsation. The efficiency realized was, however, about the same in both cases.

El Paso, Texas. JACK MORRIS.

Marking Punches Made from Discarded Gear

STEEL STENCILS are normally too high priced to provide for the individual tool equipment and, too, they are seldom used in every job that is taken up, though when it is



DISCARDED STEEL GEAR HAS NUMERALS FILED INTO THE TEETH

desired to mark parts considerable time is lost in looking up the required punch.

A set of punches which include only the Roman numerals will serve in many instances and the means which were used by one mechanic to provide a set will appeal to any mechanic as a simple and most desirable example to follow. This set of punches is shown in the accompanying sketch. It consists of a discarded gear on which the numerals are filed into the teeth on one side of the gear and the teeth stubs on the opposite side serve as the butt end which is struck with the hammer.

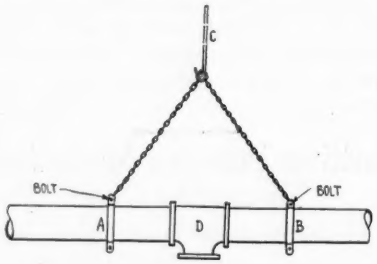
Cutting of Roman numerals with a file is a comparatively simple job; however, it is also possible to cut other forms of numerals with additional work, or to cut letters.

This tool has several advantages which are worth considering, the main one being that there is the less likelihood of losing the tool. One side of the tool may be painted or otherwise plainly marked so that it will not be used in an inverted position.

Washington, D. C. G. A. LUERS.

Simple Pipe Hanger Eliminates Vibration Noises

IN AN effort to eliminate vibration noises transmitted to our offices from steam pipe lines carried below, we hit upon this somewhat unusual method of supporting the pipes and found that it quite effectively remedied the condition. One most necessary feature of any pipe support is



PIPE LINE IS HUNG BY CHAINS FROM AN OVERHEAD SUPPORT

that it shall permit of free expansion of the pipe; this hanger has that quality. As shown in the accompanying sketch it consists simply of two lengths of chain of suitable size, two pipe clamps and some form of overhead support to hold the chain.

Toronto, Ont. JAMES E. NOBLE.

Poor Finish on Pump Valve Seat Causes Leakage

SOME TIME ago a simplex boiler feed pump developed a balky streak and would stop at the end of the stroke when running slow. Every conceivable remedy was tried, including grinding the valve seats, putting in new valves, new sheet packing between the valve deck and pump body and air chamber, new hydraulic packing in water end and new packing on both steam and water ends of the piston rod. No results showed after all this effort, except that more water was delivered when the pump did run.

Then as the last place to look was the steam end, it was opened up. The valve mechanism is of rather a peculiar construction; there are three valves altogether, one pilot valve or auxiliary No. 1, driven from a rocker arm which is connected to the piston rod. No. 1 valve has channels or ports cut in the face of it and these conduct the steam to and exhaust it from the auxiliary valve No. 2. This valve in turn transmits its motion to the main valve, which is a regulation D valve and supplies steam to the cylinder to operate the piston.

When the steam chest was removed and taken apart a rough spot that looked as though some one had taken a file and roughed it up was found at one end of the auxiliary valve No. 2 and a hump at the other end. These were removed and polished up and no more trouble was experienced.

Another cause of trouble with this pump is the packing between the steamchest and cylinder. There is a strip running lengthwise to pack the joint in division wall between the auxiliary valves 1 and 2 and this wall contains the ports for carrying the steam to operate auxiliary No. 2. The hole is where the steam exhausts after doing its work in valve No. 2. This strip of packing is ¾-in. wide and the hole is ⅜-in. in diameter. The live steam occasionally blew out the gasket, so that live steam blew straight through into the exhaust. Sheet rubber packing would not last over 10 days, as the oil, fed in for lubrication, made it gummy, much like a layer of glue. Finally, in desperation, a thin sheet of cardboard was put between 2 pieces of zinc and when cut to the right shape, shellac was put on both sides of the cardboard and the zinc gaskets on each side of that. After bolting on the steam chest, the whole was allowed to set for 2 hr. before steam was turned on. That was 5 yr. ago and it was opened up several times and put back again, but the last time the part with the hole through it broke in two, and had to be renewed.

Minneapolis, Minn. FRED S. RUTLEDGE.

Checking Up on Air Compressor Operation

IN THE plant in which I am employed it became necessary to exercise some economy in the use of water. Accordingly we began to look around for some place where a saving could be made, starting with the air compressor. The amount used by this compressor for cooling purposes was determined in the following manner:

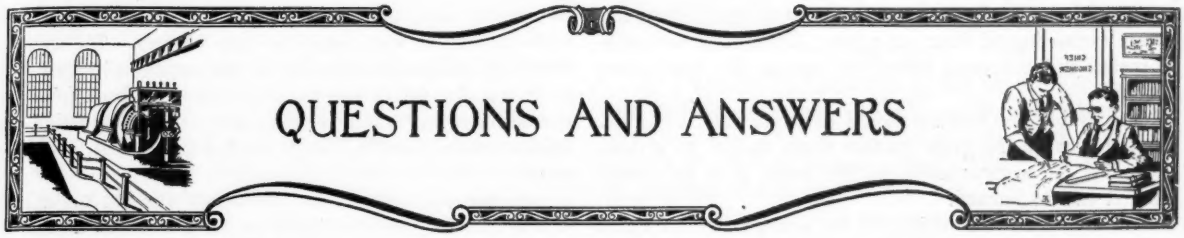
The valve controlling the supply of water to cylinder was left open to allow approximately the same rate of flow of water as was found necessary under ordinary running conditions. By turning the ¾-in. pipe away from the receiving funnel it was found that a pail of 18.5 lb. would run full in 3 min., showing a consumption of 370 lb. per hr. This was quite an appreciable quantity and it was decided to save it by using it for boiler feed purposes. Accordingly, 35 ft. of ¾-in. pipe was installed to carry the discharge to a receiver tank, from which water was taken for boiler feed purposes. The saving effected, in the use of purified water, amounted to 4070 lb. a day for an 11-hr. run.

This same compressor had been using from 4 to 6 qt. of heavy, black, steam cylinder oil, for about three weeks due, perhaps, to the absence of the engineer, and the extra efforts of the fireman to carry on during the shortage of the personnel.

Being equipped with two lubricators each of which had two adjustments, viz.: none at all, or altogether too much, the compressor was well oiled. The hydrostatic lubricator was sent to the factory and the mechanical force feed was adjusted by installing a check valve with an extra heavy spring to overcome the syphoning of the oil out of the lubricator during the working periods of the compressor. The compressor was equipped with an unloading valve and after a desired pressure was reached the air intake valve closed, allowing compressor to coast.

Investigation of the end blowoff pipe from the receiver tank netted 32 qt. of steam cylinder oil, which, after being strained, was used up later in its proper place.

Worcester, Mass. LEROY BLAKE.



Would a Trap in the Return Line Help?

WE ARE heating our buildings, about 10 of them, from a central plant. We have a two-pipe system with a vacuum pump connected to a common return. One of these buildings has about 75 radiators and coils. Others range from 10 to 25.

All of these radiators are equipped with thermostatic traps and these are depended upon only to take care of the live steam. I find that we are losing too much live steam through these traps, so much that it is necessary to use a stream of cold water in the suction of the vacuum pump.

I have renewed traps and put in new diaphragms, still I often find a new trap or a trap with a new diaphragm blowing by. I find that if this trap is given a slight tap it will act properly for the time being.

We have about 200 of these traps but for some reason they are not taking care of the situation. I find the loss in live steam is too great and too expensive to continue under this condition. Our steam pressure ranges from 5 to 25 lb.

I intend to install a low pressure trap in the return line as it leaves the building. We have no check valves in the returns from any of the coils or radiators.

What is the best thing to do under these circumstances?

M. O. P.

Effect of Inductive Load on a Circuit

WHAT EFFECT will an underloaded induction motor have on an alternating current system? What can be done to improve conditions? N. P. N.

A. The effect of an induction motor on a power system is to cause the current to lag behind the voltage. In this respect, the effect is directly opposite to that produced by a capacity load. If the circuit without the induction motor has an excess of capacity reactance, i. e., if the current leads the voltage, then the effect of adding an inductive load will be to increase the power factor. If the circuit already has an excess of inductive reactance, then the insertion of such a motor in the line will decrease the power factor.

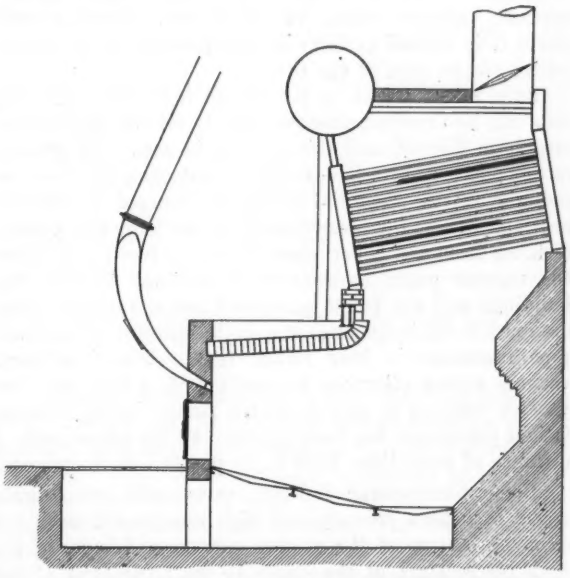
One of the inherent characteristics of the induction motor is that under light loads the power factor is reduced and in a circuit where this one motor constitutes the only reactive influence, at zero load the power factor becomes practically zero.

Obviously the most logical method of overcoming such a difficulty is to remove the cause. If it is at all possible, shift the machines around in the plant so that the rated capacity of the motor more nearly fits the load which it is to carry. To do this it may even be advisable to purchase a new motor in order that a more advantageous disposition of units may be effected.

Inasmuch as low power factor in this case is caused by an excess of inductive reactance, it follows that inserting capacity reactance in the line will serve to increase the power factor. This may be done by making use of an overexcited synchronous motor in a place where the load requirements will permit it.

Dutch Oven Setting Helps Efficiency

IN RESPONSE to the inquiry by F. S. R. in the June 1 issue of Power Plant Engineering, regarding the installation of a shipping board boiler for the burning of sawdust, tan bark, etc., let me say that I have had some experience



APPLICATION OF DUTCH OVEN FOR BURNING SAWDUST UNDER SHORT WATER TUBE BOILER

with this type of boiler for use with this kind of fuel and this experience prompts the following suggestions:

Set the boiler, front or reverse setting, as desired, not less than 8 ft., or better higher if the room allows, from the front header to the floor line.

Place a dutch oven towards the front with a flat suspended arch.

Place the grate on a considerable incline, high in front, low in the rear.

Use a stationary sawdust grate with a small air space to prevent the fine particles from falling through the grate.

Provide a dump grate behind the stationary grate.

Assuming dry wood and refuse, 36 sq. ft. of grate surface will be sufficient for a 250-hp. boiler to work up to 200 per cent rating during peaks.

With dry wood a natural draft ranging from 0.05 to 0.5 in. of water will be found sufficient.

Should the sawdust and refuse be wet, as when sawing green lumber logged down on a river, it might be advisable to install an undergrate blower to increase the draft when required.

Preferably, the furnace should be longer than it is wide. To the rear of the grate surface there should be a dead space for the accumulation of fuel when it is fed faster than it can be burned.

An article on this subject by the writer in Power Plant Engineering of May 15, 1922, may be of further interest in this regard.

Moline, Ill. EINAR WINHOLT.

Utilization of Exhaust Steam

ON PAGE 451 of the April 15 issue, Mr. Rutledge has taken some exceptions to my reply to E. W. M.'s question and I feel that he is both right and wrong in his article; right from his point of view and experiments on his plant and wrong from my point of view and experiments on my plant. It is possible to return the condensate from a vacuum heating system more than 500 ft. away with 10 to 12 in. of vacuum if the conditions are right. Thermostatic radiator return valves are not always needed where it is desired to carry a back pressure on a gravity return system part of the time.

Stop valves placed on the return end of the radiator coils can be throttled down enough to relieve the condensate from the coil and this is done in many old gravity return plants to save the expense of installing thermostatic radiator valves when the system is changed to vacuum heating. Where the factory buildings are large and a great distance from the boiler plant it is also possible to place the vacuum pump at some point mid-way between the buildings and the boiler plant and use a vacuum pump designed to discharge against a slight pressure to overcome pipe resistance in long return lines. Where sufficient vacuum cannot otherwise be maintained, a high and low vacuum trap can be used to aid the pump. In such installations condensate has been returned to the boiler room, a distance of more than 1000 ft. in plants I have operated.

Some thermostatic radiator valves will not operate where both back pressure and high vacuum are used, not so much because of the greater vacuum as because of the high temperature of the steam at the return end of the radiator which keeps the condensate at such a high temperature as to expand the thermostatic valve enough to keep it closed. On back pressure gravity return heating the friction of the return pipe lines so retards the circulation that the contraction in the radiator return valve is greater and the valve opens wider. Few radiator return valves will stand a high back pressure when used on a vacuum heating system with resulting wide range of temperature without jamming on the seats and causing destruction of the valve if more than 5 lb. back pressure is used.

Expense of installing new supply lines prohibited my critic from operating with less than 4-lb. back pressure. That is true with most old heating systems where the exhaust steam is used under back pressure for heating purposes. But in my case it was adding a new building and changing from live steam heating on the old ones to exhaust steam vacuum heating, and I added as much as possible to the system by making it a condensing return system using as much vacuum as conditions would permit, in order to make use of the returns from some large manifold coils which were used the year around. The engine was fully loaded at times due to the variation in load and as it was desired to use more machines no back pressure exceeding 1-lb., which would have meant reduction in engine capacity or the addition of a new boiler, could be used.

In war time when new machinery was not to be had it was necessary to figure close on the pipe lines, especially the supply line which had to be installed and connected to the new building as well as the radiators of the old buildings and heating system. Branch return lines came from each building to the boiler room and stop valves on each prevented the condensate from coming back too hot on any one return line, by throttling the return valve until defective radiator valves or traps could be repaired. Short-circuiting of the steam to the return lines was also eliminated through throttling radiator return stop valves in case of leaking thermostatic valves. When all was in operation the result was better than we had expected. We heated the new building and the entire plant and turned out more goods with a saving of 143,000 lb. of coal in two months.

If the supply pipe lines are large enough, any old heating system can be converted into a vacuum heating system, or can be used as a condensing return system. Condensing the exhaust from the engines removes some of the back pressure and adds considerably to the power output. Every inch of vacuum which can be maintained in the cylinder increases the economical operation of the plant and saves the expense of large return lines which have to be used on live steam or high back pressure gravity return systems.

This condensing heating system can be used in any isolated office building or factory plant where the supply steam pipes are large enough so that a back pressure of 1 lb. or less can be carried on the engine exhaust line, and I see no reason today why new installations in office or factory or other isolated plants should not have exhaust supply pipes large enough to supply steam to the heating system at small back pressures for vacuum heating.

Cambridge, Mass. R. A. CULTRA.

What Causes the Hook?

IN REPLY to the question, "What Causes the Hook?" by J. L., which appeared on page 618 of the June 1 issue, I would like to offer the following suggestions:

I presume that the indicator diagrams in question were obtained from Corliss valve engines, judging from the general form as presented. The high pressure cylinder diagrams show correct valve setting and good steam distribution throughout. The points of cutoff and the terminal pressures show good economy and apparently the high pressure cylinder is carrying the load for which it was designed, considering the steam pressure carried and the speed, and I think no improvement can be made.

Now, as to the low pressure diagrams: These show poor valve setting and steam distribution. The hooks shown at the steam end of each diagram indicate that the steam valves open slowly. This slow opening may be due to one of two possible causes, namely, late lead of the valves, or an overtravel of the wristplate, due in turn to incorrect length of the reach rod or the eccentric rod or perhaps both. I judge that the lead is not enough, and also that

the wristplate is not properly centralized. This is emphasized at the crank end. Improvement can be made in the steam valves' setting and in correcting the wristplate motion.

These diagrams plainly show that the exhaust valves open too late, as indicated by the sloping back-pressure lines. This robs the engine of a certain amount of useful power and should be corrected.

In setting the exhaust valves it is desirable to have them begin to open a little before the piston reaches the end of its stroke. If this is done the form of the diagrams will be changed so that the pressure at the end of the stroke is the normal back pressure carried and the back pressure line on the diagrams will be parallel with the atmospheric line for nearly the entire length.

To improve the present condition of affairs, it looks as though the exhaust eccentric (if there is a separate eccentric for the exhaust) should be given more angular advance so as to secure an earlier opening of the valves. If by so doing, the valves close too early a compromise can be effected by adjustments of the radial rods, which connect the valve arms to the wristplate.

As J. L. has not given the scale of spring with which the diagrams were taken nor the actual length of the original diagrams, it would only be a matter of guessing to attempt to calculate the relative power developed in each cylinder. From general knowledge and observation, however, I am inclined to think that 10 lb. receiver pressure is not as high as may be carried to obtain better steam economy. The points of cutoff, and the terminal pressures in the low pressure cylinder seem to bear out the idea that 10 lb. initial pressure is too low.

I am of the opinion that by increasing the receiver pressure to about 15 lb. better steam economy will be obtained. I base this on past experience, also on the cylinder ratios and the boiler pressure stated in J. L.'s letter. The exact receiver pressure that should be carried can only be determined by actual trial. This is not difficult to do, and any pains taken in so doing will be amply rewarded in saving made.

Brooklyn, N. Y. CHARLES J. MASON.

Pumping Hot Water

WHAT IS the maximum temperature at which it is possible to pump water, as, for instance, for boiler feed service? B. M.

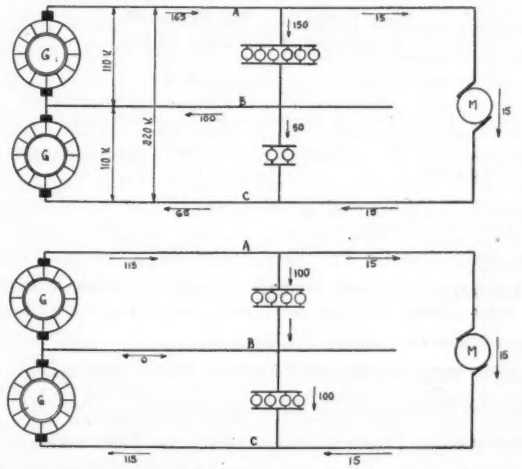
A. The temperature at which it is possible to handle water by means of a pump depends entirely upon the suction head on the pump. At a temperature of 32 deg. F., the maximum suction lift is theoretically about 34 ft. In actual practice, it probably does not exceed 25 ft. As the temperature of the water is increased this suction lift must be decreased. At a temperature of 212 deg. F. (the boiling temperature of water at atmospheric pressure), it is necessary to have a positive head of at least 5 or 6 ft. on the pump in order that it may function without steam binding. For any head less than this, there is a partial vacuum formed at each stroke of the pump and the hot water immediately flashes into steam and destroys the suction. Water may be pumped at any temperature as long as there is a sufficient head on the suction.

Pumps designed to handle hot water should have ample suction valve area, ample suction piping and a piston speed slow enough to permit the water to follow it without the tendency to form a partial vacuum.

Distribution of Load in 3-Wire D. C. System

IF A 110-220-v. three-wire system contains three hundred 110-v. lamps across one side, one hundred 110-v. lamp across the other and a 220-v. motor across the system what current would flow in each wire? The lamps take each ½ amp. and the motor 15 amp. P. A.

A. As shown in the accompanying diagram the current from line A to line C at the motor is 15 amp., from A to B 150 amp. due to the larger group of lamps and 50 amp. from B to C due to the smaller group. Thus it will be seen that the current in line A from the generator is $15 + 150 = 165$ amp. and in the line C to the generator, $15 + 50 = 65$ amp. The current in the neutral is then $165 - 65 = 100$ amp. to the generator.



CURRENT FLOWS IN THE NEUTRAL WHEN THE SYSTEM IS UNBALANCED

It should be remarked in passing that this is not an ideal arrangement. The chief advantage of such a system is that it saves copper and copper losses, when it is properly arranged. When the circuits are unbalanced to any great extent this advantage is practically lost and two two-wire systems might just as well be used. The neutral is supposed to carry no current whatsoever. A better distribution of the load would be as shown in the second diagram.

Forced Draft Fan vs. Higher Stack

IN THE issue of May 1, V. H. Carples comments on my remarks concerning the question by F. S. in the Feb. 1 issue about using a forced draft fan or a higher stack.

I find that there was a typographical error which made my letter read "the 300-hp. water tube boilers." This should have read "two 300-hp. water tube boilers," instead.

We cannot operate more than one boiler at about 125 per cent of rating with the undergrate blower without the stack failing to remove the gases fast enough to prevent them from issuing from points in the setting and breeching. With natural draft, however, the boilers can be operated at about 75 per cent of rating when running together and this is probably about all that the stack can take care of with average conditions. I therefore hold to my former contention that F. S. needs an increase in the induced draft in his plant.

East Dedham, Mass. G. H. KIMBALL.

POWER PLANT ENGINEERING

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Improvements in Manufactured Equipment

Back of every change in design of a manufactured device is an idea born of a desire either to improve the usefulness of the device or to reduce the cost of its manufacture. If such a change accomplishes either result, both the manufacturer and the user are benefited, with the greatest advantage to the user in lower cost of investment or improved efficiency, either one of which has a cumulative financial return to him.

Although many improvements have been made in power plant equipment during the past few years, resulting in enormous gains to those who have been foresighted enough to employ the most modern equipment, little credit for originating such improvements can be claimed by the users. Practically all the initiative has been taken by manufacturers who have spent great sums of money not only in developing their products but in putting them on the market, making them available in all parts of the country, creating a demand for equipment with which the user is not familiar and teaching those in charge of operation how to secure highest efficiency from this equipment.

Here is an opportunity of which many operators have failed to avail themselves. No manufacturer's laboratory can duplicate all the conditions of operation met in the field. Each installation has its peculiarities and an observant operator could, if he would, point to improvements in details which manufacturers would welcome and consider, if their application is sufficiently general. Step into any well operated plant and you will find original ideas, which should be available for use in other plants, worked out successfully by the men in charge. To develop these ideas into manufactured equipment is, in most cases, out of the field of the operator, but, by supplying data gathered during operation, he can be of great service to the manufacturer who undertakes to put the device on the market.

It is gratifying to note a growing tendency toward cooperation between manufacturer and user, particularly in the larger problems which confront the industry, such as the use of high pressure steam, reheating of steam, use of pulverized coal, air preheating, mercury vapor process and even some of the smaller equipment such as steam valves and circuit breakers, has had cooperative study which has been extremely beneficial to the industry. This is a step in the right direction and should receive all possible encouragement.

Maintaining Plant Economy

Economical operation and management of a power plant cannot be obtained or made permanent by the employment of haphazard methods. First the operators must be determined to obtain the best that is consistent with other conditions, then methods must be put into practice which are known to be effective; good practice must be maintained at all times and finally improvements must be sought after continuously.

Quite frequently when a manager reaches the decision that conditions must be improved, he becomes aware that he does not possess the talent within his organization to carry out the improvements. It is necessary for him to employ an experienced engineer or to seek the temporary services of a consultant in matters of plant operation.

Either way will no doubt prove effective but what guarantee has the manager that the engineer recently employed will not leave his service or that the bolstering up effect of the consultant will not wear off soon after he has completed his work? The answer is that the manager has no guarantee except in so far as he is willing to bring his own organization up to a consistently high standard and maintain it in that condition.

This can be done in a number of ways. One is the establishment of a fair bonus system; another is to keep the operators well versed in fundamentals through the use of special study courses and classes. A third method is to encourage the men to read and study current engineering literature. In these days of rapid progress, a text book soon becomes obsolete except as to theory. Current engineering literature keeps constantly on the trail of each new development as it is put into practice. The theory is stated and explanations are given as to why changes were necessary. Developments are described in detail and the results obtained are set forth so that merits may be judged by what has actually been accomplished.

These opportunities cannot wisely be set aside. Full advantage must be taken of them, if the initial expenditures made to obtain plant economy are to be made worth while through their continuance and further progress is to be made, thus keeping step with advancement in the field of economical plant operation and management.

Maintenance Costs Should Be Segregated

In many plants the expense of maintenance is thrown into the cost records of operation in such a way that it is not possible to segregate the replacement items and the labor which go to make up maintenance. For that reason it is not possible to determine whether maintenance is 5 per cent or 25 per cent of the operating cost.

If such costs are accurately kept, they may be used for a variety of purposes which are entirely apart from an analysis of plant performance. It is possible, for instance, to check the labor and material costs for keeping different pieces of equipment in first class operating condition. These figures may then be used as a guide in changing types of apparatus or materials.

Aside from considerations of efficiency, upkeep costs afford a strong argument for replacement due to obsolescence. If a recommendation is to be made which calls for junking a piece of equipment, a detailed record of the cost of maintenance helps to place the recommendation on a businesslike basis.

Off Duty

Often, when we are searching for something, we find something that we are not looking for but which, nevertheless, proves more valuable than the thing we originally set out to find. All of us have had experiences like that. Even Columbus, way back in 1492 could have vouched for the truth of this assertion.

Columbus, as we all know, had a hunch that by sailing westward over the ocean he would reach India. Now, to discover an easy way to India was something well worth looking for in those days, so after making a hit with Queen Isabel and inducing her to hock her jewels in order to buy some ships, Columbus set out to find India, going around the back way, so to speak. After sailing westward for a week of Sundays he finally bumped right smack up against something he was not looking for, although at the time he did not know it. He thought he had reached India when as a matter of fact he had reached nothing of the kind; he had hit America. This proved to be a good hit.

In 1894 when Rayleigh and Ramsey in England were investigating the composition of the atmosphere, they found a new gas, and thinking it might be valuable they immediately started to investigate its properties. It was not long, however, before they came to the conclusion that they had discovered a dud. It was colorless, odorless and so inert that they couldn't do anything with it. It seemed so absolutely useless, in fact, that it was named Argon from two Greek words which mean, "it won't work." So it was relegated to some dark corner where, for twenty years, it lay along with the rest of the "nobodies." It wouldn't combine with anything so nobody wanted it.

Today, however, Argon is no longer the poor neglected orphan it was, but instead occupies a brilliant position in modern affairs and has become an important member of the gas family. It is referred to as a noble gas.

In spite of its rapid rise in the world, it has never seen fit to combine chemically with anything else and is still as inert as ever. "Well then," you ask, "why this sudden change of heart—what makes it so valuable today when ten years ago one scarcely recognized it as an element?"

Why? Simply because it is so wonderfully inert. Its very inertness makes it valuable. During the entire time we were so busy trying to effect its combination with other things we were blind to the fact that it was an inert gas we needed.

The first tungsten filament lamp was a great improvement over the old carbon filament lamp but when operated at high temperatures and under the usual high vacuum conditions, the lamp deteriorated rapdily. Something was needed to prevent this rapid evaporation of the filament, and this something finally proved to be that lazy, useless member of the gas family, Argon.

Argon, today, is pumped into modern electric lamp bulbs where, in spite of its shirking disposition it *does* work. It does not combine with the metal of the filament as oxygen or other gases would, yet serves to maintain a pressure in the bulb sufficiently high to prevent rapid evaporation.

The story of Bakelite furnishes another instance, of finding something we were not looking for. Before Dr. Baekeland began his world famous work on phenol condensation products, chemists had vainly been searching for a soluble plastic resin of high insulating qualities. Hundreds of experiments were made but in each case the result of the experiment was a hard, insoluble, infusible resinous mass which apparently could be used for nothing. Finally, Dr. L. H. Baekeland attacked the problem and although at first he proceeded along the same lines as previous investigators he soon came to the conclusion that what he was after, was *not* a fusible, soluble resin, but rather the infusible, insoluble mass of material which had been the unsuccessful end of so many experiments.

In our course through life we often find our objective changed in much the same manner as in the instances related here. Unexpected things arise which apparently block our normal course of action. What are we to do in such cases; shall we brush these obstacles aside and continue our progress or shall we stop and investigate them? You alone can answer this question for yourself when it arises, and in your ability to do so correctly depends much of your ultimate success in life.

Mechanical Engineers Meet at Cleveland

FROM MAY 26 TO 29 TECHNICAL SESSIONS OF A. S. M. E. WERE WELL ATTENDED. INTEREST SHOWN IN MERCURY-VAPOR PROCESS

OF THE one thousand engineers who attended the Spring Meeting of the American Society of Mechanical Engineers, held in Cleveland, Ohio, May 26 to 29, those interested in power plant problems had their time fully taken up with technical sessions in the mornings and plant excursions in the afternoons. Nela Park, Akron and Lorain were visited by engineers in attendance and many factories in Cleveland opened their doors to the visitors. Fairmount Pumping Station and Baldwin Reservoir, now under construction by the City Waterworks, and the recent extension to the Lake Shore Station of the Cleveland Electric Illuminating Co. drew the attention of those interested in power generation.

Nominees, as presented by the regular nominating committee of the Society are:

President, William F. Durand, Prof. M. E. Stanford University, California; Vice-Presidents, Robert W. Angus, Prof. M. E., Faculty of Applied Science and Engrg., University of Toronto, Toronto, Canada., S. F. Jeter, Chief Engr., Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn., and Thomas L. Wilkinson, Consulting Engr., Davenport, Iowa; Managers, John H. Lawrence, Engrg. Mgr., Thos. E. Murray, Inc., New York, N. Y., Edward A. Muller, Vice-Pres. and Genl. Mgr., The King Machine Tool Co., Cincinnati, Ohio, and Paul Wright, Paul Wright & Co., Birmingham, Ala.; Treasurer, William H. Wiley, Pres., John Wiley & Sons, Inc., New York, N. Y.

Election will be by ballot of the entire membership, closing on Sept. 23.

EMMET MERCURY VAPOR PROCESS

As marking a new epoch in the history of power generation, great interest was shown in the Emmet mercury vapor process, the development and successful use of which was described by the inventor, W. L. R. Emmet and L. A. Sheldon, both of the General Electric Co. The author first gave an account of the early experiments made, after which the thermodynamic possibilities of the process were taken up. The 1800-kw. installation in the plant of the Hartford Electric Light Co. was described, following which boiler problems, leakage, packing and relative topics were discussed as well as the question of mercury supply. The paper also included a table of the properties of mercury vapor at absolute pressures, ranging from 0.4 to 180 lb. per sq. in., a Molier chart for mercury and a chart showing the available energy of mercury vapor in watt-hours per pound for expansions from absolute pressures of from 20 to 85 lb. to back pressures of from 0.4 to 1.6 lb. abs.

Estimates which do not admit of much error, indicate a possible average gain in output in three large central stations of 58 per cent, had the fuel in these stations been burned under mercury boilers.

Mr. Emmet does not believe that efforts in the development of mercury vapor turbines need be slacked on account of a mercury shortage. He says: "The demand for mercury has always been strictly limited and it is probably not safe to predict positively the consequences of a greatly increased demand. The cost is governed largely by the richness of the ore. Ore of various grades exists in many places and it now pays to work only the best of it. A well informed mercury-mine operator has estimated that a maintained price of $2 per lb. would call forth from known sources in the United States enough mercury, if used as we expect, to correspond in plant capacity to the largest yearly output of General Electric turbines."

As soon as certain boiler experiments now in progress are satisfactorily completed, it is proposed to build a new boiler of different type for the present plant at Hartford. This boiler will be adapted for a pressure of 70 lb. gage, the design pressure of the present boiler being 35 lb. gage. It is also intended to build a new three-stage turbine instead of the one-stage now used.

When these changes are made it is hoped that this installation will be representative of types which can be repeated indefinitely on a large scale and with such resultant economies as were outlined in this paper. Maximum economy will be obtained by bleeding the steam turbine in order to get as much heat as possible into the feed water. Since such units will not be run at heavy overloads, as is common with steam boilers during peaks, it will be practicable to put a large quantity of heat into the incoming air without burning the brickwork and it is thought that such a device as the Ljungstrom air heater can be used to great advantage in bringing the flue gases to a low temperature and delivering their heat to the furnace. The heat from the furnace will be used to heat and vaporize mercury and to give such superheat to the steam as may be expedient with the steam apparatus used.

With such an arrangement, if we assume 70 per cent efficiency, 70 lb. pressure for the mercury cycle, and the most desirable steam conditions, we should be able to operate on a base load at about 10,000 B.t.u. from fuel per kilowatt-hour. In Hartford, where oil is burned and measured, and where steam flow and feed are both measured, it has been estimated that if the steam produced were used effectively, the fuel rate would be about 12,000 B.t.u. per kw.-hr. This is with only 1200 kw. load, a

single-wheel turbine of only about 60 per cent efficiency, and with only 22 lb. mercury pressure.

Power Organization in the Steel Industry

This paper presented by Bryant Bannister and F. M. Van Deventer compared to some extent the problems encountered in the central stations and those met in the power plants of steel mills. It was pointed out that in most central stations only one kind of fuel is used whereas in the steel industry as many as seven fuels—coal, blast-furnace gas, coke-oven gas, tar, oil coke breeze, natural gas and waste heat are sometimes used.

To do full justice to the power problems the engineering organization should be directed by a company power engineer directing specialized engineers in the realms of electrical and mechanical engineering.

Although a central engineering organization is essential, the nature of operation requires an operating organization at each works of sufficient size to handle the daily volume of work and meet any operating emergency. This can best be accomplished by placing the responsibility for the operation of the entire system upon a power superintendent who should have the same standing relative to the works manager as other department heads.

In the discussion of this paper the statement was made that the expenditure warranted for improvements and their value to the power plant depends largely upon the necessity for reliability. A single interruption in power may cause a loss in production many times greater than the cost of equipment necessary to forestall such an interruption.

Interchange of power between steel mills and central stations was mentioned as a practice which has possibilities for economy worthy of consideration. The sole business of the central station is to produce power from primary fuel; that of the steel mill to produce steel, power production from primary fuel being an added expense. When power can be produced as a by-product to utilize waste heat or gases it can be generated profitably at the mill; additional power can be purchased to advantage from the central station.

Generation and Utilization of Steam in the Iron and Steel Industry

In his paper on this subject, John A. Hunter described the equipment employed in the iron and steel industry for generating and using steam. Quantities and cost of fuel and the cost of converting the heat in the fuel to steam were given. Present-day tendencies toward the design and size of equipment, as well as refinements in control were indicated and the probable savings which could be made if all of the steam required in the industry were made and consumed in the most efficient apparatus now in use were also shown.

His observations indicate that, in this industry, the average capacity of boilers now being installed is about 800 hp., the vertical and inclined-tube types being the most popular. Probably 75 per cent of the coal-fired boilers are equipped with stokers. Powdered coal is not used to a great extent.

With few exceptions those in direct charge of the boilers are practical men who have come up from the ranks but in some companies technically trained men have direct supervision of the operations. Quite generally complete records of operation are kept. The average output obtained from boilers in operation is about 110 per cent of the rated capacity. Steam pressure averages about 140 lb. with 300 lb. as the probable maximum. Feed water temperature ranges from 180 to 210 deg. and the average boiler efficiency is about 60 per cent with the maximum around 80.

As to prime movers, steam driven units seem to be giving way to internal combustion engines and the use of electric power purchased from central stations. Although figures indicate an increased use of turbo-generators and motor drives the development of the uniflow engine has been responsible for the installation of a great many steam engines.

Within the last few years the utilization of waste heat has been given a great deal of consideration. The largest source of waste heat is blast-furnace gas.

The Gas Engine in the Steel Industry

A. C. Danks, in his paper on the above subject, told of some of the difficulties met in designing and operating the first four-cycle gas engine installed in this country for operation on blast-furnace gas. This was in 1905 and many of the features of design established in this pioneer installation have withstood the test of the time that has intervened. Among these features is the method of governing by varying the amount of a uniform mixture of gas and air which he compared with other methods.

In regard to igniters he stated that the jump-spark type was found to be unsatisfactory. Likewise the magnetically operated igniter was abandoned for the mechanical make and break type.

Results of an extensive study of the mechanical reliability of gas engines were given by the author in tabulated form and he spoke in detail of piston troubles and design and corrosion due to water cooling. Charts were presented which were prepared from records kept over many years of operation, showing the costs of operation and current generation with gas engines, steam engines and steam turbines as prime movers.

Pulverized Coal in Boiler Furnaces

Pulverized fuel at the Cleveland Electric Illuminating Co.'s Lake Shore Plant was the subject of a paper presented by W. H. Aldrich. This installation was described in the May 15 issue of Power Plant Engineering; the discussion of the paper, however, brought out the fact that continuous changes are being made in powdered coal equipment and the methods of handling this form of fuel. The question of drying was up for considerable discussion. The limit to the amount of moisture which the coal should contain seems to be in the neighborhood of 4 per cent, though some consider that drying is not necessary if the moisture does not exceed 5 per cent. One case was cited where trouble was experienced with feeders when the percentage of moisture was exceptionally low.

When drying coal with the waste heat in the flue gases the temperature must not be allowed to get below the dew point of the gases, as this means will then defeat the purpose for which it was intended. Also when using this method of drying, it is essential to maintain a high percentage (16 or 17) of CO_2 in the gases to prevent ignition of the coal.

Commendation was given the designers for their judgment in installing cindervane fans for removing ash from the stack gases. Although many thought the ash from a powdered fuel stack is less objectionable than the smoke

from stoker fired plants, precautions should be taken to forestall criticism on this point from the general public.

Fairmount Pumping Station

Among the public improvements being made by the city of Cleveland is the Fairmount Pumping Station and Heating Plant. This was described in an illustrated talk by L. A. Quayle, chief mechanical engineer of the Cleveland Water Department.

Fairmount Pumping Station equipment consists of eight turbine reduction, gear driven centrifugal pumping units, three of which have a total capacity of 200 million g. p. day and pump raw water from Fairmount Reservoir into Baldwin Filter Plant; two have a capacity of 20 million g. p. day each and pump filtered water from Fairmount Reservoir into Kinsman Reservoir; three have a capacity of 20 million g. p. day each and pump filtered water from Baldwin Reservoir into Warrensville Reservoir.

Boiler room equipment consists of four 1000-hp. Stirling boilers designed for 320 lb. working pressure and 150 degrees superheat. The overhead coal bunker has a capacity of 3300 T. and the coal is conveyed into it by two pivot bucket conveyors. The coal is weighed as it comes in on automatic scales which operate in connection with the pivot bucket conveyors; and is again measured by Bailey meters as it is discharged into the stoker hoppers.

Steam is bled from the turbines at a pressure of 125 lb. into a municipal heating system supplying over 300,000 sq. ft. of radiation in residences and business blocks as far as two miles away from the plant.

Heat Losses Through Insulating Materials

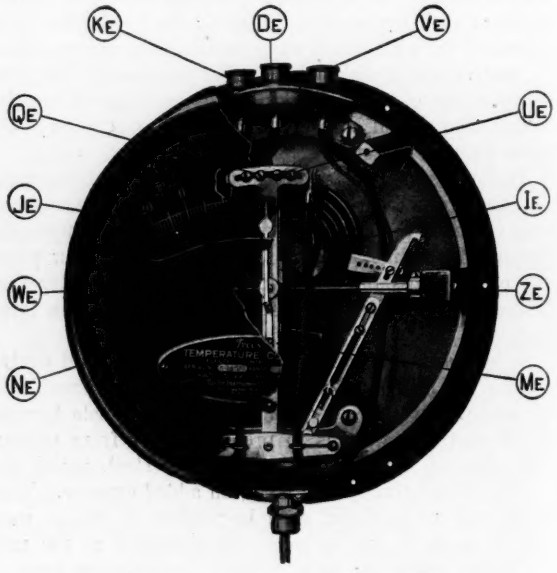
By means of the conductivity coefficients of materials used in manufacturing insulating coverings, R. H. Heilman of the Mellon Institute developed a method for determining the heat losses through insulating materials and his paper on this subject included the results of numerous and exhaustive tests on commercial pipe coverings and insulating cements, which were presented in curves, tables and formulas that can readily be used by the engineer. The experimental methods used were described briefly and the exact character of thermal conductivity and its relation to temperature gradients and differences were discussed from a physical and mathematical standpoint.

Temperature Control Is Operated in Three Ways

IN THE electric contact type of temperature control instrument, which is built by the Taylor Instrument Cos., of Rochester, N. Y., the movement of the contacts is secured through the use of mercury, vapor tension or gas. The instrument has a tube system with a sensitive member, or bulb, which is exposed to the medium the temperature of which is to be controlled. With temperature changes the medium in the tube system causes movement of a Bourdon spring "We," which movement is transmitted by a connecting link to an arm "Ie" carrying two tungsten-faced contacts at its free end. Mounted on the same center is another arm "Me," carrying two similar contacts "Qe" and "Ue," between which the arm "Ie" is free to move, thereby engaging one or the other of these contacts, depending upon the temperature at the bulb. Pointer "Ne" is fastened to arm "Me" and indicates on the scale "Je" the position of the contacts "Qe" and "Ue." The arm "Me" is independently adjustable by means of a key which is inserted at "Ze." The electric contacts may be described as common, minimum "Qe" and maximum "Ue" and are wired to their respective binding posts "De," "Ke" and "Ve," to which outside connections are made.

If the minimum and maximum contacts are set with a five-degree difference, as for example at 30 deg. and 35 deg., then when the temperature of the bulb reaches 30 deg. a circuit will be closed through the common and minimum points, and when the temperature rises to 35 deg. a circuit will be closed through the common and maximum points. The closing of these circuits can be used to operate electrical devices for controlling the temperature within the above-mentioned limits. The contact-making mechanism is the same for all three types of controls.

When adjusting for temperature, a key is inserted through the opening provided in the side of the case.



TUNGSTEN-FACE CONTACTS MAKE AND BREAK THE ELECTRIC CIRCUIT

Turning the key to the right or left raises or lowers respectively the temperature at which the common contact closes the circuit through the minimum and maximum contacts. The difference between the temperature at which a circuit is closed through the common and maximum contacts and the temperature at which a circuit is closed through the common and minimum contacts is fixed at the factory and remains constant when the control is adjusted. The construction of the case is such that this difference can be changed, however, if necessary, without disconnecting the leads; merely by removing the front of the instrument from its base.

Standard length of connecting tubing is 6 ft., exclusive of bulb, but greater lengths are furnished, up to 25 ft., for mercury-actuated instruments and up to 75 ft., for vapor-tension-actuated and gas-actuated instruments.

EVERYTHING is now in readiness to begin actual construction on the new $3,500,000 power plant of the Sioux City Gas and Electric Co., according to an announcement made by W. J. Bertke, vice-president of the company, on his return from a trip to Chicago and points east, where final plans for the plant were worked out.

N. E. L. A. Convention Features Power Problems

LOW TEMPERATURE DISTILLATION OF COAL, THE ENGINEERS PLACE IN MANAGEMENT AND SUPER POWER COME UP FOR DISCUSSION AT 47TH CONVENTION

ASIDE from the reports of the various committees of the Technical Section, the subjects of particular interest to the power industry discussed at the 47th annual convention of the National Electric Light Association at Atlantic City, on May 19 to 23, were those relating to the possibilities of low temperature distillation of coal for the central station field, the position of the engineer in relation to the management of utilities, and effect of interconnection on the development of the nation's power resources.

V. Z. Caracristi, consulting engineer of New York City, who is the designer of the low temperature distillation process which is now being installed at the River Rouge plant and at the Ford, Ontario, plant of the Ford Motor Co., described the system and gave some data of interest in connection with the possible use of the scheme in Central Station work.

Coke is produced in this method by passing the coal over a lead bath, in cast iron conveyors. Recovery of the by-products plays an important part in the economics of the process and the coke which is produced is used as a fuel for the power plant or may be disposed of as a fuel for domestic or industrial purposes. A detailed outline of the scheme, as used at the Ford plants, was presented in the Dec. 1, 1923, issue of Power Plant Engineering.

In his address Mr. Caracristi showed pictures of the ovens at Ford, Ontario, and also of the power plant which utilizes the coke in pulverized form as fuel for the boiler. He asserted that while the method involves the disposal of by-products it shows interesting possibilities for savings in large stations. Although the talk was more in the nature of a progress report he expects that definite figures will be available shortly which will warrant consideration by public utility companies.

H. O. Lobel, in discussing this development, stated that engineers should give helpful encouragement in the study of the problems involved. In his opinion, the day will come when the central stations will carbonize all of the coal used for power production purposes.

In the past year or two considerable thought has been given by engineers to problems of broadening the engineering viewpoint to include the problems of management. The Technical Section this year devoted considerable time to a consideration of this viewpoint. An address by Alex Dow, president of the Detroit Edison Co. on "Economics and the Engineer in Utility Management," and an address by John W. Lieb, vice president of the New York Edison Co. on "The Engineers Part in the Future Development and Management of Industry," focused the attention of the engineers on this subject.

ENGINEERING VIEWPOINT MUST BE BROADENED

It is the opinion of Mr. Dow that executives should have some engineering sense and that engineers should have a greater knowledge of economics. He pointed out, however, that the type of economic knowledge needed is not of the purely textbook type but should be such that the solution of an economic problem is based on the broad factors involved. He cited instances where engineering judgment in the development of a project had been sound but where the general economic problems were such as to result in failure. One of the illustrations cited was that of a reclamation project where it was found to be impossible to market products from the irrigated lands at a profit, although the engineering work was of the highest type. In the viewpoint of Mr. Dow, executives must coordinate the ideas of their stock holders, their bond holders, their customers and their employes, and the big problem is to bring all these elements and their ideas together. The engineer must acquire these viewpoints if he is to be successful in management.

Mr. Lieb in his address to the Technical Section on the same general subject stated that the engineer should study corporations and recognize that a corporation is a legal entity and what service the corporate form involves. He should study how money is obtained and should understand economic principles and be familiar with the general trend of the markets. On the legal side the engineer must become more or less at home because he is called upon to furnish legal evidence and to study or work with contracts. Employe relations, public relations, commercial activity and rate making are other things in which engineers should be interested.

On Tuesday afternoon the first session of the Technical Section with Chairman H. P. Liversidge of the Philadelphia Electric Co. in charge, listened to the presentation of the following committee reports: Accident Prevention, Charles B. Scott, Bureau of Safety, Chicago; Electrical Apparatus, H. C. Albrecht, The Philadelphia Electric Co.; Hydraulic Power, S. S. Svenningson, The Shawinigan Engineering Co., Montreal; Meters, B. Currier, the Philadelphia Electric Co.; Prime Movers, Nicholas Stahl, Narragansett Electric Lighting Co.; Overhead Systems, W. G. Kelley, Commonwealth Edison Co., Chicago; Underground Systems, W. H. Cole, The Edison Electric Illuminating Co., Boston.

In commenting on the work of the Prime Movers Committee, Nicholas Stahl, chairman, stated that of the 28 sub-committees, 11 have already issued reports, five are engaged in special investigations and the remaining 12 will issue reports at a later date. Due to this serial method of issuing reports no reports of the Prime Mover sub-committees were distributed at the convention.

IMPROVEMENT IN POWER PLANT PRACTICE

Mr. Stahl pointed out that improvements have been brought about in every department of the power station during the year so that the efficiency has increased on all equipment except the condensers. Several innovations have been introduced successfully such as air preheaters, water cooled furnaces, new types of coal and ash handling equipment and electrical precipitation of powdered-fuel ash. Active work is being done on a study of scale formation in boilers and reports indicate that the tentative specifications for fuels have worked out well. During the year 1923 the square feet of boiler surface purchased for powdered fuel installations equalled 70 per cent of the total sold during the previous 7 yr., and the furnace maintenance problems associated with the use of powdered fuel have been largely eliminated.

Mr. Stahl stated that the trend in Diesel-engine manufacture is toward the two cycle design and one manufac-

turer has announced his ability to build these engines in sizes up to 25,000 hp. Other developments of importance are being brought about by the widespread adoption of higher temperatures and pressures and the greater application of the electric drive to auxiliaries. Studies are also being made on lubrication in order to compare laboratory and service test data.

Several of the Technical Section Reports are of particular interest to power plant men and will be abstracted in detail in subsequent issues of Power Plant Engineering. One of these, the report of the Electrical Apparatus Committee, appears on page 649 of this issue.

Besides the three sessions of the Technical Section two addresses of national interest to the power industry were presented. On Wednesday evening Herbert Hoover talked to the convention by telephone from Washington on the general subject of the development of power from a national point of view.

Mr. Hoover pointed out the value of interconnection and interchange of power to the utilities and the Nation. He showed that by interconnection, a larger diversification of use and a greater evenness of load are secured by which the same size of generating equipment will take care of a much larger number of consumers.

Hoover Does Not Believe in Federal Regulation

Since such interconnection of power systems involves the flow of power across state lines, Mr. Hoover asserted that discordant methods of regulation in different states may amount to economic barriers upon free flow and thus stifle development. In this connection Mr. Hoover made a significant statement when he said that he was advised that no embargo could be constitutionally placed upon the free flow of power across state boundaries.

In his opinion Federal regulation is not the solution of these problems of inter-state movement of power. Federal regulation for power, such as has been found necessary for transportation he thought would be a disaster to the development of our power resources.

Mr. Hoover suggested that the United States would eventually divide itself into several power districts each with its own problems—problems relating to the origin of power, problems of climate, problems relating to the character of industries and uses. No regulation, in his opinion, could supply that intimate knowledge of local problems which the industry requires.

In discussing superpower Mr. Hoover made the following highly significant statements: "We have some persons who insist that the federal government should now undertake wide superpower development. Much of this discussion comes from lack of understanding of the practical aspect of the industry. We find many people enthralled with the notions of "superpower" or "Giant power" who conceive it a superimposed financial and industrial structure over all existing systems. At once, they envisage a gigantic and grinding trust in the background. As a matter of fact no super-structure of this sort is possible. Superpower means interconnection of systems and larger central stations, coal or water, scattered over the whole Union. It is in daily progress before our very eyes.

"Interconnection does not imply capital consolidation or the building up of great trusts. It implies the sale and resale of power from one utility distribution system to another, and it implies co-operative action between utilities in the erection of central stations. It must embrace municipal plants as well as corporation plants. It implies no gigantic exploitation, for that is impossible under state regulation of rates and profits."

Governor Pinchot of Pennsylvania also addressed the convention along a somewhat similar line. His idea is that interconnection is not sufficient, that the power resources, both water and steam power, must be tied together by trunk line systems in order to afford the maximum possibilities for what he terms "integration of power." Superpower to his way of thinking does not define this development as well as does the term giant power. He also spoke on the value to agriculture in a greater use of electricity on the farm.

Exhibit a Feature of Convention

There is no question but that the 47th convention was one of the most successful ever held. In addition to a full program of sessions on public relations, commercial activities, accounting methods and technical problems the social program was well planned and executed. The exhibit which featured this year's convention comprised some 136 individual exhibitors utilizing 53,000 sq. ft. of exhibit space. While these exhibits related partly to the commercial end of Central Station work there were some 60 exhibits of particular interest to engineers in power production and distribution work. The registration at the convention totaled almost 6000 and the sessions were well attended. Next year, in all probability, the convention will be held at Portland, Oregon, although that is yet to be officially acted upon.

Officers elected for the next year's work of the association were as follows:

President—Franklin T. Griffith, president Portland Railway, Light & Power Co., Portland, Ore.

First Vice-President—James E. Davidson, vice-president and general manager Nebraska Power Co., Omaha.

Second Vice-President—Robert F. Pack, vice-president and general manager Northern States Power Co., Minneapolis.

Third Vice-President—Howard T. Sands, vice-president Charles H. Tenney & Co., Boston.

Fourth Vice-President—P. S. Arkwright, president Georgia Railway & Power Co., Atlanta.

Treasurer—W. A. Jones, Henry L. Doherty & Co., New York.

Seven members at large of the executive committee were elected as follows:

Past-president Walter H. Johnson, vice-president Philadelphia Electric Co.; H. C. Abell, Electric Bond & Share Co., New York; I. E. Moultrop, Edison Electric Illuminating Co., of Boston; W. E. Robertson, Robertson-Cataract Electric Co., Buffalo; James R. Strong, Tucker Electric Company, New York; H. M. Edwards, New York Edison Co., and Gerard Swope, General Electric Co.

Mr. Johnson takes the place of former President Frank W. Smith, Mr. Swope that of E. W. Rice, and Mr. Edwards that of P. S. Arkwright. The other four were re-elected. Five additional members, E. M. Herr, Westinghouse Electric & Manufacturing Co., East Pittsburgh; T. A. Kenney, Hodenpyl, Hardy & Co., New York; W. A. Layman, Wagner Electric Corporation, St. Louis; Harry Reid, Interstate Public Service Co., Indianapolis, and E. W. Lloyd, Commonwealth Edison Co., Chicago.

Master Boiler Makers Hold Convention

ATTENDANCE at the convention of the Master Boiler Makers' Association, which was held in Chicago, May 20 to 23, brings a realization of the fact that perhaps we who have had to deal only with problems in the stationary engineering field may have something to learn from locomotive practice and in return may be able to throw some interesting sidelights on their problems. Several points were brought out at this meeting which should be of some interest to power plant engineers.

Notable among these is the extensive use made of welded joints in boiler construction. During the last 10 or 15 yr. great advances have been made in the art of both autogenous and electric welding and it now supplants to a considerable extent the use of rivets in the fabrication of boilers. Nowadays almost all locomotive fire boxes and combustion chambers are made up in this way.

In making up a riveted joint, the efficiency may be foretold with a certain degree of accuracy, provided, of course, that the work is properly done and the quality of the workmanship can be readily ascertained by inspection. Such is not the case, however, with welded joints. If such a joint is properly made the efficiency may exceed 100 per cent; that is to say, the joint may be stronger than the plate itself. On the other hand, a poor joint might have an extremely low efficiency and the fact would not be apparent from a superficial inspection. The presence of gas bubbles or slag in the weld reduces the strength materially and these defects do not always manifest themselves even to the experienced eye. As a consequence, then, the full responsibility for the efficiency of the joint is placed on the welder and your confidence in the job must be measured by your confidence in the ability of the man who did it, which must of necessity be a variable factor. To keep a check on this factor it is the custom in most shops to require every welder to submit a sample of his work for test at certain stated intervals.

Practice has developed welders whose work is perfectly reliable, consequently welding is being used more and more and on an increasing variety of applications. This development has been paralleled to some extent in the power plant field, especially as it applies to work not directly subjected to furnace temperatures. Along this line, however, we seem to have been a bit backward. There is probably a very good reason for this condition. Insurance underwriters are not anxious to issue insurance on welded joints for the reason that they have no means of knowing how the job was done.

Ordinarily, on stationary boilers, welding is allowed only on parts where it does not have to be relied upon to take the full stress of the steam pressure. Such parts as pipe joints and flue connections in the tube sheets come in this category, for here the weld is only for the purpose of securing steam tightness. Even for such applications, however, the welded joint is the exception rather than the rule.

Treatment of Boiler Waters

Much attention was given at this meeting to the subject of boiler feed waters. As compared with stationary practice, locomotive boilers operate under a decided disadvantage in this respect, changing as they do from one source to another of entirely different characteristics in rapid succession. Various systems of treatment have been tried at the numerous watering stations, but it has been found more or less impractical to maintain the treatment to correspond with the changes in the character of the source. As a result, there has been a tendency to over treatment followed by a marked increase in pitting and corrosion in boilers all along the line.

To combat pitting and grooving by what was thought to be galvanic action, extensive use has been made of zinc electrodes suspended inside the boiler shell but results have indicated that the maintenance cost was too great to justify their use. In this connection, one road reports that it has met with some success by the use of what they call polarized mercury chemicals.

It is possible that much of this corrosion is caused by dissolved oxygen in the water, but little if any attention has been given to this phase of the situation. Whether or not it would prove practical to make use of some system of deaeration for this class of service remains to be seen.

If any such system were employed, units could not, for obvious reasons, be installed at the watering stations but would have to be included as a part of the locomotive equipment. Whether the extra cost, maintenance and operating charges would be justified by the results obtained, only an actual test under operating conditions would show.

Boiler Cleaning

Boiler cleaning as practiced in the locomotive boiler may offer something new in way of shop kinks. It seems to be more or less common practice to clean locomotive boilers by means of a sand blast. The system is to direct a blast of sand under both water and air pressure directly against the scale. Results seem to indicate that this method accomplishes the desired results in an entirely satisfactory manner. Whatever ill effects the sand may have on the blowoff valves is considered of but little importance. The blowoff valve on a locomotive is a simple quick rising gate on which the effect of erosion is a minor item. Whether or not this method of cleaning could be economically applied to stationary boilers where erosion of valves is a more costly item might be worth considering.

New Station in Kentucky Completed

Completed in less than a year, the new $3,500,000 steam generating station of the Kentucky Utilities Company, near Pineville, Kentucky, adds another great central power plant to the impressive list of physical properties of the Middle West Utilities Co. This station, which was placed in operation April 30, has initial development of 22,500 hp. Ultimate capacity under present plans will be 45,000 hp.

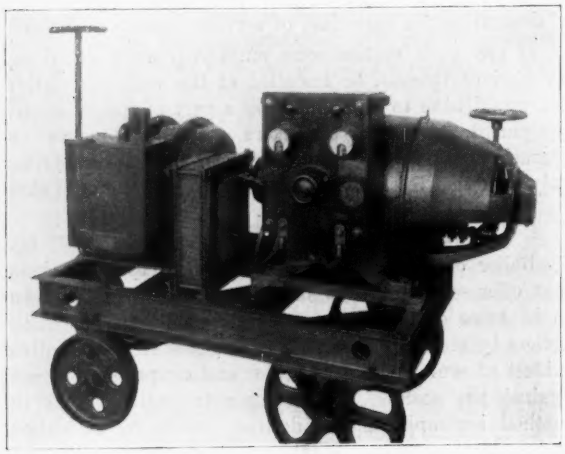
The Pineville project eventually will supply power for a large and important Kentucky territory, embracing even Louisville, as it will be a supplemental power source for the hydro-electric development on the Dix River by the Kentucky Hydro Electric Co.—another Middle West subsidiary.

A power line, approximately 100 mi. in length, will connect the Pineville plant and the Dix River station as soon as the latter is completed in the spring of 1925. A transmission line of 80 mi. will deliver to Louisville whatever portion of the combined output that city requires.

New Portable Arc Welder

SEVERAL features of interest are embodied in a new portable arc welder which has recently been placed on the market. The welder is a two unit set, with a self-excited generator which eliminates the necessity of a separate exciter. Generator voltage can be adjusted to suit the work. High voltage may be used for complete penetration of heavy work and light voltage to prevent burning through on light work. Commercial sizes of metallic electrodes from $\frac{1}{16}$ to $\frac{1}{4}$-in. may be used. Any value of current between 75 and 300 amp. can be obtained in a large number of steps between these limits.

This welder is a product of the General Electric Co. and consists of a two-pole, self excited, constant energy, single-operator machine with a dual magnetic circuit designed to operate at 60 v. open circuit and 20 to 25 v. under load. It is rated at 200 amp. for continuous service,



STABILIZING REACTOR AUTOMATICALLY STEADIES THE ARC UNDER ALL WELDING CONDITIONS

250 amp. for 1 hr. and 300 amp. for short periods. The motor is a standard General Electric 10-hp. unit. The complete set has three bearings, the two units being close-coupled by a solid flange coupling. All parts, including generator, motor, generator control panel, motor starter, and stabilizing reactor are mounted on a welded steel structural base. The assembled unit is about 63 in. long, 29 in. wide and 47 in. high, weighing 1600 lb.

Among the mechanical advantages are included motor and generator insulation designed to withstand severe operating conditions both with regard to duty cycle of load imposed and general atmospheric conditions under which ordinary insulation fails. Bearings are waste-packed and oil cannot be spilled if the set is tipped when being moved.

News Notes

ANNOUNCEMENT HAS been made that the H. S. B. W.-Cochrane Corporation will be known in the future as the Cochrane Corporation. The dropping of the initials, which stood for the Harrison Safety Boiler Works, has been made simply for the sake of brevity, the organization and products remaining the same.

EDWARD GORDON, who has for the past 7 yr. been connected with the Consolidated Gas, Electric Light & Power Co., of Baltimore, Md., acting in the capacity of combustion engineer, test engineer and finally, assistant superintendent of steam stations, has taken a position as chief engineer of the Williamsport plant for the Potomac Edison Co. Mr. Gordon is a graduate of Johns Hopkins.

LE VALLEY VITAE CARBON BRUSH Co. has moved its offices to the Grand Central Terminal, New York City.

SHIPMENT WAS recently made by Engberg's Electric and Mechanical Works, of St. Joseph, Mich., of thirteen engines to the Standard Oil Co., at Toledo, Ohio.

UNION MALLEABLE IRON Co. of East Moline, Ill., has let a contract to Erie City Iron Wks., Erie, Pa., for pulverized coal equipment for its four boilers of 150 hp. each. each.

ON JUNE 1, James E. McDevitt, formerly with the New York sales office of the Standard Heater Co., joined the sales organization of the Ash Reclaiming Machinery Corp., of New York City.

S. OLIN JOHNSON, president of the Penberthy Injector Co., Detroit, Mich., died May 17, at the age of 76 yr. Mr. Johnson was one of the founders of the Penberthy organization and for 40 yr. he has been actively identified with its affairs, acting as president for 30 yr.

A. L. BRADFORD, formerly chief engineer at Okmulgee, Oklahoma, for the Oklahoma Power Co., has accepted the position of consulting engineer for the Magnolia Gas Co., of Dallas, Texas. W. L. Carpenter, formerly chief engineer for the Oklahoma Power Co., at Henryetta, Okla., succeeds Mr. Bradford.

THE HARVESTER PLANT of the John Deere Co. of East Moline, is adding one B. & W. Stirling boiler to take care of the scrap wood and sawdust of the plant, relieving the other four boilers. The new boiler will also be equipped for oil burning so that when short of sawdust, pressure can be maintained.

DIAMOND POWER SPECIALTY CORPORATION, of Detroit, Mich., has appointed W. L. Sullivan, 505 Central National Bank Building, Tulsa, Okla., as its representative for the State of Oklahoma. Mr. Sullivan has been in Tulsa for several years specializing in the sale of power plant equipment and machinery.

ELLIOTT Co., of Pittsburgh and Jeannette, Pa., announces some recent changes in the sales department. R. K. Williams, formerly of the Cleveland office is now district sales manager of the Detroit office, taking the place of W. R. Danley, resigned. R. W. Fox, of the New York office, has been transferred to the Cleveland District.

R. W. WILKERSON, who has for the past 8 yr. been chief engineer of the League Island Navy Yard, Philadelphia, Pa., has taken position of chief engineer at the Millville, W. Va., plant of the Northern Virginia Power Co. Previous to taking charge of the League Island power plant Mr. Wilkerson spent 10 yr. as a U. S. naval engineer, with headquarters in Philadelphia.

BASSICK-ALEMITE CORPORATION announces the purchase of the Allyne-Zerk Co., of Cleveland, Ohio, which will be operated as an independent unit under the holding company. E. W. Bassick, of Bridgeport, Conn., will continue as president of the holding company, taking an active part in the management and in the work of the Executive Committee which includes as other members E. S. Evans,

E. E. Allyne and James G. Alexander. E. S. Evans becomes vice-president of the holding company, in charge of sales.

CHARLES H. BAKER has joined the staff of the Sessions Engineering Co., Chicago, Ill., as chief mechanical engineer. He received his early training in the foundry, pattern and machine shops, also power station operation with the Boston Elevated R. R. He graduated as mechanical engineer from the Lawrence Scientific School in 1902.

Since that time he has been identified with the following companies: Westinghouse Church Kerr & Co., as engineer in New York City; Brooklyn Rapid Transit Co., as power station inspecting engineer; N. Y., N. H. and H. R. R. Co., as assistant chief engineer, Coscob Sta.; Boston & Maine R. R. and Berkshire Street R. R. Co., as chief engineer Tunnel Sta.; Public Service Electric Co. of N. J., as mechanical engineer; Diamond Alkali Co., as consulting engineer. He is a member of the American Society of Mechanical Engineers.

M. D. CHURCH has been appointed general manager of the Moore Steam Turbine Corporation, Wellsville, N. Y. Mr. Church has spent practically his entire life in steam turbine work. Graduating from Syracuse University in 1906, he was later in the employ of the Kerr Turbine Co. for a period of 6 yr., during which time he served as assistant chief engineer and factory superintendent under the late J. L. Moore. For the last 9 yr. Mr. Church has acted as chief engineer for the Terry Steam Turbine Co.

WORK WILL begin at once on two of 10 new units to be included in a new $3,500,000 power plant at Holtwood. Interests reported to be identified with the Pennsylvania Water and Power Co. have formed the new company which will be incorporated under the laws of Pennsylvania and allied with the Pennsylvania Co. and the Consolidated Gas, Electric Light and Power Co., of Baltimore. The new plant will adjoin the one of the Pennsylvania Water and Power Co. at Holtwood, Pa., and will go in operation early in the spring of 1925. The new plant will have an ultimate capacity of 100,000 kw. Contracts for the building of the first two units have been placed in New York.

PHILADELPHIA ELECTRIC CO. has placed an order with the General Electric Co. for two 50,000-kw. turbo-generators for its new power plant. The generators will be delivered next year, so as to be installed in time to take care of the 1925-26 peak load. Foundations are being laid for the new plant at the foot of Erie avenue, Delaware River. It will be built in three sections of 200,000 kw. capacity each.

Books and Catalogs

PRACTICAL CALCULUS FOR HOME STUDY, by Claude Irwin Palmer; size, 4¾ by 7¾ in., 443 pages, cloth; New York, 1924. Price, $3.00.

As may be inferred from the title, this book is designed to meet the needs of those who find it necessary to get along without the assistance of an instructor, to give the man without college training and with but limited mathematical training the ability to make use of the calculus as he needs it in his work. To this end explanations are detailed and quite comprehensive. Many illustrations and analogies are included to assist the student in getting a firm hold on the essentials of the subject. Numerous examples involving the writing of differential equations of engineering problems are included.

The emphasis in this treatment is upon the practical applications of the principles of calculus and the explanations are as non-technical as possible but the accuracy of precise mathematical methods has been retained. While the presentation is non-mathematical, it is not unmathematical.

Experience shows that it is almost impossible to proceed very far into any branch of technical science without coming into contact with the calculus. In attempting to circumvent calculus, more time may be spent in solving a problem in some roundabout way than by meeting it fairly with the aid of calculus. While such methods may often lead to correct results, they are time wasters.

To keep in touch with the developments of science, one should be able to read books and periodicals in which the language of calculus is used, to understand at least the fundamental processes by means of which the formulas in common use are derived.

While the subject of calculus can not be made easy in the sense that no effort will be required to master it, it can be made plain so that one can, without an elaborate background of mathematical training, understand the fundamental concepts.

OIL ENGINES, by A. L. Bird; First Edition, 281 pages, cloth; New York, 1923. Price $5.00.

This book has been prepared for the student and user of oil engines in general. It does not cover any one type in particular but is intended to present a broad survey of the subject by assembling special problems and results heretofore scattered in different publications, by giving a historical view of the evolution of the oil engine and by presenting an indication of the probable lines of its future development.

Chapter headings are as follows: historical and introductory, cycles of operation, oil fuel and its combustion, charging the cylinder, injection and ignition of the fuel, characteristics and test results, mechanical details peculiar to oil engines and present positions and future development.

No attempt has been made to deal with the usual methods of design in its wider sense, as it is anticipated that the trained engineer approaching the subject of oil engines for the first time, will, having once grasped the principles involved and forces acting, do this for himself.

Mathematical treatment of a simple character has been adopted, thus leaving a considerable portion readable by those interested only in results. The contents are based partly on lecture notes and partly on practical observation.

OIL AND GAS ENGINE POWER, by A. W. Daw and Z. W. Daw; 7 by 11 in., 468 pages, 232 illustrations, 81 tables; New York.

This volume is intended not only to describe how the development of the internal combustion engine has proceeded but to give a comprehensive and up-to-date exposition of the fundamental principles governing the combustion of gas and oil fuels with compressed air and expansion of the burnt gas in the engine cylinder; as well as a clear and concise treatment of the basic principles governing the construction of the internal combustion engine for the different purposes to which it is applied.

Opening chapters deal first with a brief history of the internal combustion engine. Then follows a study of the

atmosphere which is followed by an exhaustive study of the fundamental physics of air and gas, the relations of air and gas and the work of compression and expansion of air and gas.

Chapter six consists of 27 pages devoted entirely to the subject of fuels for internal combustion engines. Numerous tables are given showing the composition of various fuels and their physical and chemical composition. Many of the less common fuels such as power alcohol, hydrogen and acetylene, are discussed. Temperatures and pressures resulting from the explosion method of combustion in gas engine cylinders and explosion limits of fuel gas and air, as well as the speed of ignition are given full consideration.

One important impression gained in a survey of this book is the thorough and clear manner in which all mathematical discussions are presented. In many instances not only is the mathematical theory given but there is also given a practical application of the theory as well as a statement as to the reasons wherein practice does attain that which was anticipated from theory.

Full discussions are presented upon the subjects of engine indicators and indicator diagrams; producer gas and light and heavy oil engines. Chapter 20 covers the principles of engine balancing both from the viewpoints of theory and shop practice.

Of further interest to the student and engineer are discussions on the effect of steam in its co-operation with and reaction on the combustion cycle and the future development of the internal combustion engine. This book is well supplemented with a great variety of valuable tables.

TEMPERATURE MEASUREMENTS in Generators, Transformers and Cable Systems make up the subject matter in bulletin No. 871, issued by the Leeds & Northrup Co. 4901 Stenton Ave., Philadelphia, Pa. Since temperature is practically the basis for load control in the case of electrical equipment, considerable discussion is devoted to the principles involved in taking readings of temperature which will accurately indicate the conditions of operation. In discussing cable temperatures, it is stated that disturbances usually arise from the combination of effects such as the load on the cable itself, the heat originating from other nearby cables, heat from adjacent steam pipes and heat from dielectric losses. It is pointed out that operators cannot take care of these conditions with ammeters and wattmeters and that some direct form of temperature measurement is needed. Furthermore, since some of these temperature effects vary along the length of the cable and cable duct, operating companies whose lines run through congested districts have found it necessary to make temperature surveys of their cable system to locate the hot spots, after which cables are operated with those hot spots directly in mind. After taking up such general discussion on the problems of temperature measurement, the thermocouple-detector, potentiometer system and the resistance coil detector, Wheatstone bridge system, are described.

"ELLIOTT-EHRHART AIR EJECTORS" is the title of catalog C2, which is now being distributed by the Elliott Co. of Jeannette, Pa. In taking up the subject of air ejectors, considerable information of a general nature is presented which enables the reader to understand the reasons for the use of this equipment, the advantages and a history of the development of this apparatus. Sections on the selection and application of ejectors for condenser service, and a description of the various types of ejectors built by the Elliott Co. follow the general discussion.

"BOILER TESTS WITH PREHEATED AIR," which is an abstract of a paper by C. W. E. Clarke, Power Engineer of Dwight P. Robinson & Co., is now being distributed by the Combustion Engineering Corporation, Broad Street, New York City. In this paper Mr. Clarke has shown the general arrangement of air preheaters and some of the results which have been secured with this equipment at the Colfax Station of the Duquesne Light Co.

MULTICOIL FEED WATER HEATERS are discussed in Bulletin No. 103, issued by the Standard Water Systems Co., of Hampton, N. J. This heater is made up of three principal elements: shell, water chambers and heating coils. Instructions and details are shown and dimensions of the various sizes of heaters are given. Piping arrangements for heater installations of this type, are suggested and illustrations show several typical installations.

ENGBERG'S INSTRUCTION BOOK, covering instructions for the installation, operation and care of engines, has been published by Engberg's Electric & Mechanical Works, St. Joseph, Mich. This is a 31-page bulletin which shows by diagrams and photographs the various points which must be considered in the care of small steam engines such as are used for stoker drives and for small generator sets. A section on the care of generators discusses the causes of excessive sparking, adjustment of brushes, care of commutators.

L. J. WING MFG. CO. has just issued a new bulletin of its Type E. M. motor driven blowers for forced draft, describing these direct-connected blowers which are especially adapted to heating boilers but also to any other boilers of moderate size where motor drive is preferred for the forced draft. The bulletin tells of the economy to be had by burning the low-priced coals costing $4 to $6 a ton in place of the sizes usually used in heating plants which cost $10 to $14 a ton. There are a number of illustrations showing various types of installations, with dimensions, tables of capacities and horsepowers required.

"AN UNUSUAL HISTORY OF PETROLEUM" has recently been published by the Tide Water Oil Sales Corporation, 11 Broadway, New York City. This is made up of the material which was first used in 12 folders and which has now been combined to make an exceedingly entertaining bulletin. It is a fantastic chronicle of the development of petroleum. It takes up the development of primordial man and his contact with petroleum from ten million years ago up to the present time. The illustrations are cleverly handled and while the arrangement is one with entertainment as its motive, there are enough facts given to make it of educational value.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO. has recently published an 8-page circular, entitled "Supervisory Control." In this circular the general principles of operation and construction of both audible and visual systems of supervisory control for automatic substations are set forth.

Supervisory control has been developed to afford reliable means of communication with and control of unattended stations. It is essential that any form of this control equipment translate the orders of a system operator into electrical impulses, convert these impulses into actual operations and then inform the operator that his orders have been carried out.